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TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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FISH, FOREST AND GAME PROTECTION IN QUEBEC.

By Hon. Honore Mercier,
Minister of Colonization, Mines and Fisheries, Quebec, Canada.

I esteem it a great privilege to take part in the proceedings of this convention and to profit by the experiences of the many here assembled who are distinguished authorities upon the subject of conservation in general and fish and game in particular. Many of you come from states where the lack of proper conservation in the past necessitates the propagation of game as well as its protection, and all of us understand that present failure to protect what game we have must soon result in its complete disappearance. The extinction of the great auk, of the wild pigeon and the wild buffalo are constant reminders of the duty imposed upon us, of passing on to those who shall come after us, the rich supply of fur, fin and feather which has come down to us from former generations. Even in the vast Northern wild lands of the country from which I come, and in the far northwest of Canada, as well as in its far northeast, conservation is the duty of the hour, and active measures are essential to restrain the greed of gain from playing havoc with the remaining fauna of our northland.

Let me occupy a few moments of your time in telling you of some of the problems which confront me and the officers of my Department and of just a few of the natural conditions of our province; a province which has some claims upon your consideration, not only because of the very great numbers of sportsmen from these United States who go there for their fishing and hunting, but because of the vast numbers of your game birds which have their breeding grounds there.

The Province of Quebec, today, occupies just double the territory of the Quebec of five years ago. Prior to 1912, it had an area of 351,873 square miles. In that year, all the territory of the mainland of North America to the north of our then northern boundary, extending to Ungava Bay and Hudson Straits, having a superficies of 351,780 square miles, was annexed to our province, giving us a total area of 730,653 square miles, or over four hundred and fifty millions of acres. In other words, we have now a province

about one-quarter as large as the entire United States, six times the area of the British Isles, and three and a half times as large as either France or Germany.

Fully ten million acres of our territory is covered with water. Not more than 50,000 square miles of our total of 730,653 square miles is organized territory and even of this latter a large part is still covered with forest growth, and the balance, outside of the cities and towns, is but sparsely populated. Five thousand souls would probably prove to be a very exaggerated estimate of the entire population, whites, Indians and Esquimos, of the northern half of the province, or less than one inhabitant to each 70 square miles. In the interior of this vast territory various kinds of fur and feathered game roam practically undisturbed. Marvellous stories are told of the enormous quantities and size of the salmon and sea trout of Ungava Bay, of the white or polar and other bears of our northern coast, and of the trout of the Hamilton and other inland waters.

The richest and rarest furs of the black, silver, cross and white fox, of the mink, marten, fisher, skunk, otter and muskrat, come from our far north. It is estimated that the Province of Quebec furnishes more than half of the four million dollars worth of furs shipped annually from Canada to the United States, in addition to the large quantities exported via the Hudson Bay route to London and Paris by the Hudson Bay Company, Revillon Freres and others, and without taking into consideration those which are manufactured for local consumption. Until last year the province received no return whatever from its large production of furs, but the new law which I had the honor of submitting to the Legislature, gives my Department perfect control of the trade in native pelts, and imposes upon them a royalty of something like 5 per cent. of their value. Thus the people of the province are now sharing, to a small extent at least, in the large profits which the fur-dealers have been receiving out of one of our country's important natural products. This revenue will give us the means of creating a still better organization for protection and conservation.

By far the larger production, so far, of Quebec furs marketed are taken in the wild portions of the southern or more settled parts of the province, so that a large measure of protection,

based upon a proper observance of closed breeding seasons, is necessary to the maintenance of the supply. Propagation, in the shape of fur farming, has been encouraged since 1913 by my Department. In that year we published a small handbook on the subject, for the guidance of farmers who desired to add this branch of industry to their farming operations, and we also issued permits for the capture, at any time, of a limited number of fur bearers for parent stock. Previous to 1913 only a few isolated attempts at fur farming had been made in Quebec Province. At the present time, there are over fifty private ranches there for the propagation of fur bearing animals, and some of them have been extremely successful.

In the Province of Quebec, matters connected with fish and game have always been under the control of one of the Ministers of the Crown, responsible to the Legislature. At present, and for some twelve years past, it has been under the management of the Department over which I have now the honor to preside—the Department of Colonization, Mines and Fisheries. The Fish and Game Branch is one of the principal divisions of this Department.

Outside of my departmental assistants in this branch, we have a large and efficient staff of fish and game guardians. Of these no fewer than 138 are salaried by the government. There are 55 voluntary guardians without salary, (that is, sportsmen and conservationists) who because of their attachment to the cause, have asked to be sworn in as provincial wardens for the protection of fish and game, and who render efficient service without public reward of any kind. The 512 lessees of fishing and hunting rights in Quebec employ and pay 600 club guardians, making a total of 793 official fish and game wardens. All of these, including the club guardians, have commissions as fish and game wardens issued by the Department. Every one of them has the power of a constable.

Just here a word of explanation is necessary concerning the 512 lessees of fishing and hunting rights above referred to. The Province of Quebec is the only one of the Dominion which offers to sportsmen the practically exclusive privileges of fishing and hunting over large tracts of forest, lake and river territory. These privileges are leased to residents and non-residents alike. Non-

residents who are lessees of such privileges, or who are members of a club leasing the same, are entitled to non-resident fishing and hunting licenses at the lowest rates, which are only one half the prices charged to other non-residents, and in some instances even less.

The unsettled territory of the Province of Quebec, as I have already shown, is enormous, so that, notwithstanding the fact that over five hundred leases have already been granted to sportsmen, there are thousands of miles of good sporting territory still available for private preserves. Many of these leases of fishing or hunting territory, or of both fishing and hunting privileges combined, are held by private individuals; but over two hundred fish and game clubs are incorporated in the province, nearly all of which are lessees of fishing and hunting territory.

Some clubs, having a large membership and controlling fishing and hunting rights, exercise these rights over extensive tracts of country, from one hundred to two hundred square miles each in extent. Others are, of course, very much smaller. The law limits to two hundred square miles the extent of territory that may be held for hunting and shooting purposes by any one club, and five dollars a mile per annum is the minimum price that can be charged for shooting privileges.

The amount of rental charged for fishing rights depends upon both their quality and accessibility. The prices paid for them are in every case exceedingly reasonable. Leases for both shooting and fishing privileges are usually made for a term of five years, but are renewable for similar terms, though always at a comparatively slight advance in the rental, because of the increasing demand for such rights and their rapid improvement in actual value.

Many clubs and private individuals erect comfortable camps upon their leased fish and game preserves, and some of them have built really luxurious summer homes in the gorgeous woods of our north country, often overlooking a charming bit of lake or river scenery. Here they spend their summer vacation or come to enjoy their autumnal or winter hunt, often accompanied by the members of their families.

Now, let me emphasize this: the protection of fish and game was the main purpose of the leasing system, and this purpose it has

admirably served. In the incorporation of fish and game clubs, it is the principal object for which the incorporation is granted, and in all the leases of either fishing or hunting territories, the main condition of the lease is the protection of fish and game and the enforcement of the fish and game laws. It is in consideration of this protective work that the valuable privileges of practically exclusive fishing, hunting and camping are leased on liberal terms to Fish and Game Protective Clubs and to individual sportsmen.

Some of the clubs have quite a large membership, and in addition to their club-houses, their territories can now boast the existence, in various picturesque surroundings, of private camps or bungalows or other summer homes.

The Province has the benefit of the personal conservation work of its lessees of fishing and hunting rights, and of members of fish and game clubs, as well as of the 600 guardians employed by them, and in their own interest they become protectors of the forest as well as of the wild life of the woods. The importance of this forest protection is kept carefully before sportsmen in all the advertisements and other publications of the Department.

There is also quite an army of fire and forest rangers under control of the Department of Lands and Forests, and all of these are also ex-officio fish and game wardens. These men are almost constantly in the woods, and are therefore in an excellent position to detect infringements of the law. The members of the provincial Police and Detective Department are also fish and game wardens ex-officio.

This staff of wardens succeed in securing a fairly satisfactory enforcement of the fish and game laws, and in prompt detection and punishment of offenders. They have also the benefit of the aid of fish and game protective associations in Montreal and Quebec, composed of several hundred members each. These associations also employ fish and game wardens appointed by my Department, which gives an annual grant towards the payment of their salaries and expenses.

Our staff of wardens succeeded, between the 1st of January, 1916, and the 1st of July, 1917, in obtaining more than 350 convictions for violations of the law, involving fines to a very large amount. Among those recently prosecuted for infringement

of the game laws are some of the oldest and most influential corporations of Canada. One of these companies after a number of other prosecutions, which failed to procure respect for the law, has been lately condemned to a total fine of several thousand dollars, exclusive of the costs, and involving also the confiscation of 2000 pelts. These skins, of which three-quarters are beaver skins, represent a total value of about $7,000.00. We firmly believe that such results as these will produce excellent effects, proving to the average citizen that game laws are not enforced alone against the lower orders of the people, and showing the wealthy that none are rich enough or influential enough to be above the reach of the law.

I have referred to the intimate connection between forest protection and the conservation of fish and game. It may interest you to know what our province has done and is still doing for the conservation of its forests. It has a system of fire and forest rangers which includes the services of nearly a hundred forest rangers and about four hundred fire rangers and each of these is also, ex-officio, a fish and game warden. They are appointed by the Department of Lands and Forests and their names are suggested by the lumbermen who have acquired the right to operate in parts of the Crown forest. These holders of timber limits have been organized by the Department into co-operative associations for protection against forest fires and they receive every year financial aid from the Government.

It would be interesting for members of an association like yours to go through our game laws and see how severely we are now dealing with poachers. Records are kept of all infractions and we have in the Department a copy of every judgment rendered. We have the name of every one against whom an action is taken, the nature of the offense and also the place where it occurred. This allows us at a glance to pick up the record of former offenses and by sending to the prosecuting officer a copy of judgment obtained previously, to establish before the court the status of the accused.

For a third offense, there is now a fine of from one to five hundred dollars for each infraction. That is to say, if a person is caught with 100 beaver skins, he is liable to a fine of $1,000.00 up to $5,000.00.

But if we believe that it is our duty to protect the game on our territory, we believe also that it is our duty to work in conjunction with our neighbors and to help them protect their own. This is the reason why, during the last session of the Legislature, I had a special section inserted in the law which empowers me not only to seize game taken illegally on the territory of the Province of Quebec, but also game unlawfully killed or taken outside the province and brought in, and to send such game to the proper authorities of the state or province where it was illegally taken.

This part of our law has already been put into operation with two of our Canadian provinces and I am ready to work it out with the State of Maine and any other state which may be interested.

The salaries of the fire rangers are paid by the lumbermen who have acquired the right to operate in portions of the Crown forests. Our forests, capable of producing saw logs, pulp wood, etc., cover 130 millions of acres. Of these, six to seven millions are in private hands, the balance being public property, though the right to cut timber on 45 million acres has been let to lumbermen. From these leases and from stumpage dues on timber cut on these "limits," as they are called, the province derives a large revenue every year.

The value of our standing timber has been conservatively estimated at six hundred millions of dollars. The necessity for a scientific management and efficient conservation of this valuable domain inspired the Government of Sir Lomer Gouin in 1905 to take steps looking to the establishment of a skilled forestry service. Two young men, who now head that service, were sent to the Forestry School at Yale. After graduation they visited the principal European forests, and organized the Forestry Service in 1909, which was followed the next year by the opening of a School of Forestry at the University of Laval, in Quebec. The Forestry Service has charge of the forest rangers, and includes thirty-three forestry engineers. Under its system of inspection the wild lands of the province are classified as to their suitability for agriculture or for forest growth. Waste lands and those which have been stripped of trees and are unfit for agriculture, are being planted with nursery stock.

Reforestation is being encouraged in every possible way and a provincial nursery for forest trees has been established at Berthierville, capable of producing millions of infant trees. Since its establishment more than 1,500,000 infant trees have been shipped to the lumber companies, private individuals, scholastic institutions, etc. With all due precautions against forest fires and with a generous encouragement of the reforestation movement, there is reason to look forward to an increased rather than a lessened area of forest growth, so essential to the national wealth and the conservation of our water supply and fish and game.

There are several forestry reserves in our province. We have also three fish and game reserves: the Laurentian Park, 2531 square miles; Trembling Mountain Park, 14,750 acres, and Gaspe Park, 2,500 square miles. The first one is already organized and the others also will soon be organized.

I feel that I should not conclude these remarks without congratulating you upon the final adoption of the treaty, between the rulers of our respective countries, for the protection of migratory birds, in the passage of which considerable interest was manifested by the Department over which I have the honor to preside. Our laws have been for many years past in unison with the provisions of this treaty, and if they had not been so it would not have taken long to have made them so.

IMPORTANCE OF A PERMANENT POLICY IN STOCKING INLAND WATERS.

By John W. Titcomb,
State Fish Culturist of New York.

Had I been requested to talk on this subject twenty years ago I should have accepted the invitation with less hesitation than I did for this occasion. The longer and more varied one's experience in the conservation of the aquatic resources of this country, the more apparent and complex become the difficulties which present themselves when attempting to discuss the subject in a brief address before an association which is national in scope.

I shall therefore confine myself specifically to waters of the latitude with which I am more familiar, but at the same time I shall outline a plan which may be applied to all states.

Just at this crisis in our history the fishery resources of the country are receiving especial attention and many impractical recommendations have been made by well intentioned persons who are not familiar with the subject, as well as by some who, from selfish motives, want to let down the bars to conservation and to disregard the laws of nature which are the basis for regulations in regard to the methods and seasons for taking fish. A recent news item says that "By direction of the Governor of Wisconsin, the Conservation Commission of that State will seine all rivers within their jurisdiction for rough fish to combat the rising prices of foodstuffs." Another item says that "Iowa will probably be the first State to amend the laws in order to permit the free use of rough fish in the Mississippi River." College professors have come forward with recommendations to loosen up on the laws for the protection of fish during the present war. Incidentally I may say that similar appeals are being made to those in authority with reference to the taking of all kinds of game.

In commenting on this let me say that *proper regulations for the protection of fish are as essential to the stocking of our waters as is fish culture and all efforts relevant thereto, and that if the fishery laws of the various states were fundamentally right before the war they are just as essential today as they were then.*

In a crisis like the present one, it is quite proper that we should scrutinize our fish laws with a view to ascertaining whether they are sound, and if not, steps should be taken, by legislation if necessary, which will permit the taking of fish to the fullest extent permissible *without depleting the annual supply;* but all the regulations with reference to the fisheries should be so administered that the annual crop of fish next year and in years to come will be greater than it is this year. Let us hope that we may never be obliged to draw upon our national resources to the extent of depletion, but let us properly conserve our resources now in order that we may be prepared to meet any emergencies which may arise in the future.

There are undoubtedly instances in nearly all states where food fishes, which do not readily take baited hooks, are protected at all times by laws which permit the taking of fish by angling only. In many waters the presence of carp, suckers and other rough fish is a hinderance to the natural reproduction of the species which it is desired to encourage. In such instances the commissioners or those administering the laws should have authority to remove and to permit others to remove such fishes under proper regulations. In other words, the farming of a body of water should be with a view to maximum annual production of the kind of fish crop that it is desired to produce. Fishes which are detrimental to that crop should be treated as vermin. Fortunately this sort of vermin, at the present time, is a valuable food resource if made available.

I do not imagine that you expected a dissertation on protection in connection with the restocking of waters, but you will agree with me that regulations are as essential to the attainment of results as is fish culture in all its phases.

Fish Commissioners come and go. I am sorry to say that I have seen only a few here today whom I have met at earlier conventions, which I have attended during the past twenty-seven years. Now what shall we do to overcome this condition? We have good men on the Boards of Commissioners, who are serious minded, self sacrificing and public spirited. When first appointed most of them know very little about conservation, either fish cultural or protective. The more they are connected with the work the more interested they become and the more they realize

its importance. Soon after they begin to be thoroughly interested and to learn about the needs of the various waters under their jurisdiction, out they go and a new commission is appointed.

In the early days, those who were interested in fish culture or in restocking waters, knew less about the subjects than they do today. Very few people realized the seriousness of introducing to certain waters fishes which were not only indigenous, but on the other hand were antagonistic to the native inhabitants of such waters. Consequently many more mistakes were made then than are made today. In the Northern States, especially in New England and New York State, when the trout became depleted, it was discovered that the basses, both large and small mouth, are very prolific and that the introduction of a few pairs into a depleted trout pond showed quick results. As a sequence the commissioners introduced the bass into many trout waters.

The bass increased rapidly and thrived until the few remaining trout were exterminated. When this food was exhausted, the bass, in several instances, became a stunted race because of the lack of food; in other instances they furnished indifferent fishing. Some of these waters are of too small area and of too low a temperature to expect satisfactory results with the bass, which require large range and more food than the trout which they replaced, but the bass are there and what are we going to do about it? They do not easily respond to poison as do many other species. If the pond or lake can be drawn to a small area, either by excavation at the outlet or by siphoning, it may be possible to clean them out and start over again. This plan is feasible only in comparatively few waters. For other waters we must accept the bass permanently and in order to make the waters most productive it is important to introduce some other species which will not only furnish food for the bass, but will also produce food for the people who are not expert anglers. One of the commonest fishes to be introduced has been the yellow perch. It is a very prolific and good food fish and has the advantage of being easily caught by women and children.

In many waters, such as I have described, pickerel have been introduced, not usually by the commissioners, but by individuals. Trout waters which contain pickerel, but which do not contain black bass, may be restored to their former conditions by destroy-

ing the pickerel by the use of copper sulphate. In most instances, however, this is too large an undertaking, and here again the production of a lake may be increased by the introduction of yellow perch, and if the waters are of large area the pike perch may prove a valuable acquisition. Some of the waters which I have described are fed by trout streams and, if they are quite cold, the bass or other introduced enemies of the trout may not be so serious a menace to the latter, if the protective close season is not applied. In such instances those most competent to judge should decide upon the species, which, under existing conditions, will produce the best results.

If it is decided to specialize with trout, stock with that species annually and introduce food for them if necessary. Give the commissioners power to annul the close season on black bass for that particular water, or have the open season the same as for the trout. In other words, do not protect two antagonistic species of fish in the same waters, or attempt to please the tastes of both the trout fisherman and the angler for bass by restocking the same waters with both species. Another way to encourage the trout in such a lake and at the same time reduce the number of bass, is by screening the nests of bass before the fry scatter, making it possible to thereby effect their removal to suitable rearing waters, or directly to waters in which it is desirable to specialize with the bass. It may be that some natural trout lakes contain also yellow perch. It is a very simple matter to annually patrol the shallows of the lake during the spawning season of the perch and to take up and transfer the spawn of the perch to hatcheries, or directly to waters where it is desired to encourage the perch. These suggestions with regard to the removal of bass fry or perch spawn are equally applicable to other species of fish, and it may readily be seen that by carrying out this policy, one is not only conserving the trout, but is also conserving the young or eggs of a species of fish objectionable in that particular water, but very valuable in some other body of water.

In the state which I represent, three species of trout are propagated, namely, native brook trout, the German brown trout and the rainbow, or steelhead trout of the Pacific Coast. Experience has shown that both the brown and rainbow trout are very destructive to the native trout, and yet they are a valuable

acquisition to some waters of the state which, during the summer, become too warm to meet the requirements of the native species.

In looking over the records of the past eighteen years I find that one of the more important lakes in New York has been stocked with thirteen different species of fish. Without enumerating the species, you all know that it is impossible to expect successful results with so many species, and you also know that many of these species must have been antagonistic to each other. Undoubtedly there were applications for all of the species that have been introduced. There is a tendency among anglers, who do not give a thought to the serious results which may follow, to ask for some new species which they have heard about, or which they have enjoyed catching in some waters to which they were native. It has been the habit of fish commissioners to cater to the many tastes of the individuals. It is impossible, however, to suit every individual in one particular water. The trout fisherman must go to the natural trout waters and the bass fisherman must go to the waters which are naturally productive of bass, in order to obtain good fishing.

Lake Sunapee, in New Hampshire, is well known to anglers from almost every state in the Union. This lake also has received many species of fish. I wrote one of the former commissioners of New Hampshire in regard to this lake. His reply was "Fishing all gone to hell; not a salmon this spring. The Chinooks were good for a time, but do not reproduce and have all been caught out. They have dumped lots of fish in the lake, but they seem to do us no good." I might go on giving specific illustrations of this kind indefinitely, but it is unnecessary. You all know the conditions of your own waters and whether you are propagating or protecting in the same waters species which are antagonistic to each other.

It becomes apparent that in order to obtain the best results, a permanent policy must be established with regard to each stream, pond or lake which is to receive attention. In other words, the commissioners of the different states should have a survey made of all the waters under their jurisdiction which are to receive any attention in the way of restocking. The results of the survey

should be published in such a way that the successors of those who establish the policy may have something to guide them in their efforts with reference to the same waters.

In New York State a beginning has been made along these lines by investigation of the streams of Oneida County. This county has an area of 1100 square miles and is drained by four river systems. The fish producing power of these waters is unusually large. During recent years several fish and game protective associations have assumed almost entire charge of the planting of these streams with trout and in most instances it has been the custom for these associations to apply for brook, brown and rainbow trout for each public stream, notwithstanding the fact that it has been conclusively proved that brown and rainbow trout are very destructive to the native brook trout.

The working plan resulting from this investigation has proven most satisfactory. It has been found desirable to take the entire river system into consideration; not merely individual systems, for brown trout planted in one stream in the system will in time work into the other systems, unless prevented by dams or other obstructions. This change made as the result of these working plans will tend to eliminate much waste of the state hatchery products and to develop the streams of the country to their highest efficiency as fish producers. It is hoped that similar work may be done in other counties to the end that a permanent policy may be made as a guide, not only to the state authorities who have to do with the stocking of such waters, but also that the United States Bureau of Fisheries, in response to applications for fish to stock the waters of New York, may act in unison with the State authorities with reference to the treatment of these waters.

In Vermont a step in the same direction has been taken by using the State Highway Map on which the various lakes and ponds have been brought out in strong colors and numbered. A key to the map accompanies it, and opposite each number information is given as to the name of the pond, its present inhabitants, water area, whether the pond has been reservoired or not and the future policy as to the kind of fish to be introduced. If the state and federal authorities of the future adhere to this policy, a great waste of good material will be avoided.

The information as to whether a pond is reservoired or not is given for the guidance of prospective purchasers of shore property for summer homes. In some instances the reservoiring of lakes is harmless. As to how the fishing will be affected depends upon the extent of the abnormal conditions created by reservoiring the waters and then drawing them at seasons of the year other than the natural ones for a large outflow. On general principles, the lakes and ponds which are most unlikely to be reservoired and drawn—in other words, the waters which are most likely to remain natural—are the ones in which the future fishing can be relied upon to be as good or better than it is now. It is a fact well recognized in other states that the reservoiring of lakes for water power purposes is detrimental to the fishing. For illustration, Rangeley Lake in Maine has been twice raised until now it is eighteen feet higher than the natural level. As a result, the trout fishing in the most famous of Maine lakes has been gradually falling off ever since the water level was raised.

The question of increasing the food fishes to meet the crisis under present war conditions has led to recommendations indicating that many people do not realize that fish caught by angling are food fishes, even though they are also catalogued as game fishes. It must be borne in mind, however, that many of our waters are better suited to the cultivation of so-called game fishes, like the trouts and basses, than they are for the species of fish commonly described as commercial fishes.

The selection of a proper species of fish when attempting to stock any body of water is of utmost importance in order to obtain permanent results. It is not necessary to have special application blanks for the different species. The form which is to be filled out by the applicant should give sufficient information to guide the commissioners in the selection of the species of fish to be assigned. The preference of the applicant should be stated, but unless it is a species which will produce the most satisfactory results and be in conformity with a permanent policy, an explanation should be sent to the applicant as to the kind of fish assigned and the reason for making the assignment.

Next, if not equal in importance, to a proper species of fish for stocking a given body of water, is the manner of fish planting.

Ordinarily it is left to the applicant to plant the fish. He is usually furnished with printed instructions how to plant fish; sometimes he reads these instructions, but very frequently he does not do so. It is necessary therefore to have a campaign of education as to the importance of properly tempering the water when transferring the fish from the cans to the waters which are to be their permanent homes, as well as other important features for the attainment of successful results. It is almost impracticable for any commissioner to undertake to supervise the planting of fish, except in waters where large quantities of commercial fishes are being introduced. For the game fishes it is expected that the local anglers will be sufficiently interested to receive and plant the fish, but nothing but constant hammering will educate these people to persevere in their enthusiasm at the time of receiving fish until they have actually got them into the waters in proper condition. When it becomes known that an applicant has not properly followed the instructions as to planting fish, any further applications from him should be refused.

I have been discussing a policy with reference to ordinary streams, ponds or lakes. The policy with regard to waters of large area may be varied somewhat from the permanent policy which should be established with the smaller lakes. The species to be selected for the larger lakes is dependent to some extent upon whether reliance is to be placed on artificial propagation to maintain the supply, or whether, after once introduced, a protective close season and natural reproduction are to be depended upon.

In any attempt to establish a permanent policy with reference to the selection of species for stocking a water system, it is apparent that the farm fish pond and the privately stocked and posted stream must be under the supervision of the commission and that the proper selection of species to be encouraged in these privately controlled waters must be made with reference to its effect upon the inhabitants of the public waters to which they are tributary.

In this connection I ask your indulgence while I wander from the subject to say that we should encourage the fish pond on the farm by furnishing fish to stock such private waters at cost, just as the states supply trees at cost for reforestation.

The owners of artificial ponds which do not receive a supply of fish from public waters, but which are stocked at the owner's expense, should have perfect freedom to take the fishes from these ponds at all seasons, but they should be under the direction of the commissioners as to the species propagated when such ponds empty into public waters.

In the encouragement of fish ponds on farms, progress in this direction will never be what it ought to be until the public are educated to recognize private ownership of fishes which are artificially propagated or privately controlled in ponds privately owned. Under present conditions public sentiment is such that people will steal fish who will not steal umbrellas.

The owner of the private fish pond must also be encouraged and educated as to how to construct his pond and as to the results he may expect from the utilization of his waters. He should also be instructed as to the species of fish that will probably thrive best in the proposed pond. I recently had an inquiry from a man who wrote as follows: "I have a small lake of fresh, running water. I would like to raise in it flounders, carp and pike; let me know whether these fish will stay in such waters." It is needless to comment before a body of fish culturists as to the ignorance of the public on this subject. Another man recently wrote asking for young fish for a lake 75 by 175 feet, and expressed a preference for pickerel, bass, trout and white perch. You will all agree with me that one cannot off-hand make recommendations for the kind of fish suitable for this man's little pond, but to give you an idea of the action taken in this matter there follows a copy of the letter which was written in reply.

"Receipt is acknowledged of your letter of May 7th, making request for a number of species of fish for a small lake 75 by 175 feet. From the size of the pond it is assumed that it is a lake over which you will wish to retain your personal control, and for that reason will not want to receive fish from the state which would necessitate opening the waters to the public. If such is not the case, it is suggested that you use the enclosed application blank to describe more particularly the water and give other information called for. If you desire to purchase fish, the commission will give you a list of dealers, and in that case if you will fill out the

portion of the application blank which describes the lake more particularly, this office will be in a position to advise you as to which species to select. The introduction of pickerel, bass and trout to so small a body of water means that the pickerel and bass would quickly destroy all of the trout. They would then prey upon each other until it would be a survival of the fittest. For a lake of that area neither pickerel nor bass is suitable. If the waters are sufficiently cool, with a constant flow of cold water through the lake, trout are recommended."

SUMMARY.

In summarizing, allow me to condense what I have said and to add to it by making some specific recommendations.

1. List the waters under your jurisdiction and establish a permanent policy as to the species with which you will specialize in each.

2. Prohibit the introduction of any species of fish foreign to the waters, unless approved by the commission, and also the introduction of any species contrary to the established policy; this to include connecting privately stocked and controlled waters.

3. Co-operate with the United States Bureau of Fisheries in the adherence to a permanent policy as to the selection of species for restocking waters in which both authorities are interested.

4. Give the commissioners power to exterminate and market rough fish at any time and by any means, either directly or by the issuance of licenses. By rough fish is meant those kinds which are antagonistic to the maintenance of a successful, permanent policy already decided upon. It is immaterial for statistical results whether fish are taken by nets or by hook and line. How fish are taken should be regulated according to local conditions and effects upon property values. In this connection the value of recreation, as an asset in its effect upon property values, must not be under rated.

5. The selection of species for planting in any water system should be determined with reference to a permanent policy, in the hope that our successors will continue the policy which we have established.

6. A campaign of education as to the importance of care in planting should be waged in order to save wastage.

7. Educate the public also to appreciate private property rights in fish when privately propagated entirely under the control of the owner.

8. In the present crisis, conservation of our resources is of greater importance than at any previous time in our history, and proper regulations for the protection of fishes is as important as fish propagation.

9. The farming of our waters should be with a view to maximum annual production of the kind of fish crop that, after careful investigation, it is decided to specialize in.

10. The retention in office of men conversant with the propagation and protection of fishes is essential to insure the best results.

11. Finally, build for the future generations regardless of present political conditions. Leave a monument for yourselves by setting an example for your successors, whether of the same political faith or not. Set a pace for them and turn over to them such complete records of your work that there can be no excuse for not following the permanent policy which you have established.

FISH WASTE, PAST AND PRESENT.

By Dr. S. P. Bartlett,
U. S. Bureau of Fisheries, Quincy, Ill.

In presenting this paper I wish to say that I have no idea that I am stating anything that is particularly new, or much that is educational. I presume that this and kindred subjects will be fully covered by abler men than myself, but it is possible that it may introduce into the discussion some features peculiar to certain localities and therefore not touched upon by others. I intend to deal particularly with conditions as I have known them on the Mississippi and Illinois rivers.

Away back there more years than I care to contemplate now, when then there were no protective laws, the supply of buffalo, the principal market fish, was so large that people seemed to take it for granted that it was inexhaustible. Bass, crappie, sunfish, perch, etc., bore little part in the commercial lists, and as I have said, the buffalo was the food fish for the markets. With an improvidence hard to understand, the farmers and the fishermen took advantage of the season when these fish most needed protection, the spawning season, when the fish, rolling in shallow water, became easy victims. With any and every kind of device they took them by the thousands, and, unfit for food at that season, they were not only destroying them but their natural increase as well.

Taken in such immense quantities, they had to be marketed at once, if saved at all. They were shipped by boat, generally to St. Louis, from points all along the Illinois and Mississippi rivers, in barrels, sugar hogsheads, crockery crates, boxes, anything procurable, dressed if time permitted, or rough when it did not. So many were offered, at times, for shipment that I have seen a large proportion refused by the boats, and such as were left spoiled of course, as no ice was used. The boats being en route for only ten to twelve hours at most, the fish were packed and shipped, if possible, the day they were caught. Most of the fish thus shipped were on consignment, and investigation showed

that more than one half of the shipments were dumped into the river, owing to a glutted market and the soft condition of the fish. I have seen numbers of account sales showing a balance due the consignee, the sales failing to pay freight.

Such wholesale depredations on the supply could only result in its depletion, if not its extinction, and the output decreased so rapidly that the number of fish dealers dwindled down to only a few here and there, in the towns along the rivers, who shipped dressed fish to inland towns and sold locally. The buffalo were nearly out of the market and the game fishes, bass, crappie, sunfish, perch, etc., became favorites and were sought for in the markets. These conditions were finally brought to the attention of the state legislatures and the result was the enactment of protective laws, but the buffalo never regained its former status as the principal commercial fish. Carp were introduced into the public waters and by their rapid growth and increase have supplanted the buffalo and taken first place in the market as a coarse fish.

So much for the fish waste of former years, before the importance of fish protection and conservation was understood, in those lavish days when all of nature's gifts were under-valued because of their bountiful supply. What can be said in excuse of the waste in supply, the indifference shown in failing to utilize every pound of food and every means available to increase the quantity in these days of enlightenment, when one is urged daily to do all in his power to conserve and increase all the resources of the nation? Not only could fish be a part of the economy of every farm, but the methods of the market fishermen are as wasteful as in former years, though in different ways.

Let me illustrate: Seining in Illinois waters is lawful from September first to April fifteenth of the following year. The earlier seining is usually in warm weather. Many of the seines are from 1000 to 1500 yards in length and are handled, as a rule, by gasoline winches. The fish taken are put in live boxes and either transferred to others or anchored to await time for use. Many of the fish die from injuries in the seine or live boxes and it is not unusual to find the surface of the water in the live box in the morning covered with dead fish. These are all thrown back into the river, not only a loss, but a menace to the health of the com-

munity as well. The live fishes in the boxes are taken out as wanted and dressed, the offal thrown into the river, usually taken into the current of the river and allowed to float away. This refers only to the coarse fish, as bass can not be taken lawfully with seines or nets at any time in the year and sunfish and crappie, strange to say, are slow at markets and the waste in dressing them is light, as they are scaled and the heads left on. Fish confined in live boxes suffer greatly, as they are usually crowded, the water generally warm and the slow current changes the water correspondingly slowly, so that a considerable percentage always die and, as stated before, are dumped into the river again.

As soon as seining is lawful in the state the big seines are put to work on the Illinois river in the great stretches of water such as Peoria Lake, Havana Lake, Meredosia Bay, and in similar places along the Mississippi river. In all my knowledge of the fishing industry, I have noticed that it has been the custom of the smaller fishermen to take their fish daily to a fish boat or market and sell them in the rough. Here ensues more waste as only such fish as are lively enough to keep in their boxes are paid for, or, if the fish are needed for immediate dressing and shipment, only those red in the gills are used and the rest go overboard, as a rule. Frequently the fish taken from nets which have not been raised for a day or two in warm weather, are thrown out at the time or taken to the shipper with the others and all that are not fresh are thrown into the river there.

Some years ago I was coming up the Illinois river on the steamer "Illinois," then working jointly with the U. S. Fish Commission, and after passing the dam, a Government lock at Kampsville, we ran into a stream of dead fish floating on the surface of the water—thousands of them. This continued for fifty miles, frequently great fields of them covering almost the entire surface of the channel of the river, then a thin stream of them, but always dead fish in sight. When investigated as to the cause, it proved to have been a large catch all along the river with warm weather and a glutted market, and fish dying in live boxes were thrown into the river—a criminal waste of good food through bad methods and lack of care. This was not a frequent occurrence in such numbers, of course, but is not unusual to some degree, as a trip along the Illinois in a boat or launch will prove.

Another product of the fish is lost and wasted which could be utilized to great profit, as I have reason to believe. I refer to the universal practice of throwing into the river all of the waste resulting from dressing and preparing fish for market. In dressing buffalo, carp, catfish and the like, the scales, skin and head with collar bones and entrails are thrown into a tub and later dumped into the river, and this waste matter constitutes an important percentage of the fish.

One instance that I recall will serve to illustrate the amount of such matter that is thrown into the river, its value lost and the waters polluted at the same time. Some years ago in early spring, when the ice started to move in the Illinois River, fish seeking security on the lee side of an island moved into Moscow Bay, situated below Havana. The bay was at a good stage and fed by springs in part, thus affording earlier clear water than the river generally. A lot of farmers living near discovered the run of fish and joined seines with the fishermen, for farmers then, as now, carried seines as a part of their equipment. They surrounded the bunch of fish and the haul netted 300,000 pounds. Seine brails were brought ashore, the seine well staked and fish were taken out with dip nets and hauled away as they were wanted. The weather was cold and it took a couple of weeks to complete the job. Then the fish, or most of them, were cleaned and shipped. All the offal from the catch followed the usual route, and the greater part of all such refuse after dressing fish is still being dumped into the rivers. All the waste of the fish that is thus thrown away could be utilized, the fat be rendered into oil and the other parts converted into fish meal and used as food for hogs or fowls. Not only the refuse can be so utilized, but the dead fish should also be rendered.

In the use of a seine, large or small, scarcely a haul is made that does not bring ashore immense numbers of hickory shad. They are considered worthless and are simply shaken out of the seines and left on the shores to decay, a menace to health and comfort, if nothing more, but if they could be saved they would give a fair return in oil and fish meal. This I have seen demonstrated years ago, but the experiment failed to pay because at that time the Illinois laws prevented the use of the seine. Now

what are the possibilities of conserving this wasted product for the benefit of the people as well as for those engaged in fishing for market. I take it that in order to carry out the implied instructions of the federal authorities, the greatest attention should be given to conserving everything that can save waste. Along the Illinois River alone there is thrown overboard enough valuable product to aggregate in the course of a year a large amount of money, reckoned as hundreds of thousands of dollars. How to save it so as to make the salvage best worth while seems to be the question.

I have been interesting myself in the problem and, after seing some of the experiments made by Dr. Chas. W. Greene, of the University of Missouri, at work at Meredosia and points on the river in the interest of the United States Bureau of Fisheries, I am convinced of the possibilities of securing practical results and I am indebted to Dr. Greene for many valuable suggestions.

Dr. Greene was making some experiments on the eggs of carp and other fish for a possible use for caviar. This material, from the carp and buffalo, particularly early in spring, can be had in great quantities, at points along the Illinois river, for the taking. The shovel-bill or spoon-bill, which had a large run this season, would furnish a large supply also, if their eggs were taken early enough, and would seem to offer a valuable factor in this industry. More than a hundred thousand pounds of shovel-bills were caught, dressed and shipped to St. Louis markets as sliced or boneless catfish, selling F. O. B. at Meredosia at fourteen to seventeen cents a pound. Enough waste was thrown away from these fish to have paid a fair profit, if it could have been saved.

Dr. Greene took five and one-half pounds of fat from the belly of a spoon-bill, a strip along the belly, as I understood it, as the fat if cooked with the fish is objectionable. From this fat he rendered two and two-fifth pints of fine oil, which from appearance and subsequent analysis, after being clarified, proved to be equal to some of the fats used for cooking. Dr. Greene also advanced what seemed to me practical ideas as to saving all waste in dressing and also the dead fish now thrown away; the dead fish to be utilized by extracting the oil and converting the residue into fertilizer, while the waste procured in cleaning fish, after removing

the oil, may be made into fish meal for feeding. The material of all the waste saved would be at least valuable as a fertilizer and perhaps some of it might be profitably used as food for hogs or fowls. This would bring good prices with grain so high.

How this could be utilized with economy sufficient to make it profitable, is as yet an unsolved problem. I have been obtaining literature on the subject from the various manufacturers of the apparatus necessary to the work, but so far find the cost of the outfit too great for practical working, as, if only one outfit was possible, the cost and difficulty of transportation and of time would have to be considered. The points at which the largest quantities of fish are dressed, Peoria, Havana, Beardstown and Meredosia, could maintain small outfits perhaps, but none of them a large one.

It is possible that the next session of the Legislature will enact laws prohibiting the throwing of masses of refuse of this kind into the rivers, polluting the waters, which would necessitate some other method of disposing of it, and perhaps this may result in saving it.

PRODUCTION AND DESTRUCTION OF THE FOOD FISHES OF THE GREAT LAKES.

By S. W. Downing,
U. S. Bureau of Fisheries, Put-in-Bay, Ohio.

In discussing this question we will confine our remarks to the conditions on lake Erie, and more particularly to that portion of it bordered by the States of Ohio and Michigan. In the beginning, it would seem that nature so adjusted the production and destruction of fishes and all other animal life, that the natural increase and losses just about balanced. In course of time all the waters, both of the ocean and the fresh inland bodies, became well stocked with fish and the numbers were steadily maintained so long as the natural conditions were not disturbed, but as soon as mankind discovered the value of fish for food and financial advantages, an unnatural loss was created. At first this loss was but slight, but as more fish were consumed and the demand and price increased, more effective means were employed. Today the demand and the price have so advanced that every means that man can devise are used in taking fishes. The consequent result has been that natural production could not keep pace with natural destruction when combined with the artificial destruction carried on by the commercial fishermen in order to meet the constantly growing demand for fish as food. In order to restore the balance to normal or natural conditions, this artificial destruction must be overcome, and to do this many means have been suggested and tried and production by artificial or protected propagation has been adopted. We will endeavor in this article to show the number of young fish so produced at the U. S. Fisheries Station at Put-in Bay, Ohio, together with that of the Ohio State hatchery, which is but a stone's throw away from us, by the following table covering the output of the past sixteen years.

At The U. S. Station.

	WHITEFISH	PIKE-PERCH	HERRING	LAKE TROUT	PERCH
1902	125,472,000	55,000,000	20,200,000	.....	.....
1903	200,500,000	160,087,000	.....	.....	.....
1904	71,125,000	145,000,000	1,500,000	884,000	.....
1905	53,250,000	139,275,000	23,300,000	913,000	.....
1906	120,300,000	152,800,000	3,400,000	900,000	.....
1907	140,000,000	135,400,000	50,000,000	897,000	.....
1908	87,500,000	229,000,000	35,010,000	.....	.....
1909	190,000,000	80,000,000	3,200,000	.....	.....
1910	139,000,000	80,250,000	.....	.....	10,000,000
1911	75,020,000	89,375,000	70,300,000	.....	.....
1912	191,100,000	116,280,000	.....	.....	.....
1913	197,300,000	46,500,000	.....	.....	3,000,000
1914	163,200,000	69,600,000	.....	861,000	.....
1915	209,000,000	56,400,000	3,400,000	350,000	.....
1916	175,500,000	68,300,000	.....	.....	.....
1917	203,500,000	115,500,000	.....	990,000	.....
Total	2,341,767,000	1,740,767,000	210,310,000	6,607,000	13,000,000

This shows a total production of all kinds of fish at this station during this period to have been 4,310,551,000, or an average of nearly 270,000,000 for each of the sixteen years considered.

During the same period the Ohio State hatchery produced and liberated in the same waters, 642,000,000 whitefish, 1,194,-000,000 herring; 558,000,000 pike-perch; 10,000,000 perch and 6,000,000 saugers, a total of 2,410,000,000.

The fish produced by fish cultural work in this one vicinity in sixteen years has been as follows: Whitefish, 2,983,767,000; herring, 1,404,310,000; pike-perch, 2,298,767,000; perch, 23,000,-000; lake trout, 6,707,000, and saugers, 6,000,000; making a grand total of 6,722,551,000 fry produced by the two stations. This number added to the natural production resulting from the eggs deposited by the fish themselves upon the natural breeding grounds, gives us the production of that part of Lake Erie upon which the fish cultural work under consideration was conducted, and there can also be added to the lake at large the product of the Pennsylvania State hatchery at Erie, and that of the hatchery conducted by the Canadian Government.

Of course we are not claiming that the 270 millions of fry produced each year at the U. S. station at Put-in Bay, or the millions produced at the other stations means a production of that number of adult fish each year. Neither can we give even an approximate estimate of the number that reach maturity in the Great Lakes, but judging by the percentage known to have reached the age of reproduction after having been liberated at the fingerling stage, we think that it is safe to estimate that at least ten per cent. of all the fry liberated would reach maturity if not destroyed by other than natural causes. If so, then there were produced each year from this station alone 27 millions of fish and averaging them at two pounds each, we have a production of 2,700 tons a year. As the kinds of fish propagated are of the best varieties and sell for the highest prices in the market—perhaps an average price of 12½ cents a pound to the consumer would be a fair estimate—this would give us a production of $675,000 worth of fish each year. To digress a little from the subject, I will say that the total cost of this production, including salaries, pay for eggs, temporary labor, both in the field and at the station, the upkeep of the station, together with the maintenance and the entire cost of operating the Steamer Shearwater, which is used in collecting the eggs and distributing the fry, has averaged less than fifteen thousand dollars a year. This leaves a clear profit of $660,000.00 a year. So much for the production, now we will endeavor to consider the destruction and some of the conditions which cause it.

The natural destruction begins with the loss of the fertilized eggs deposited by the parent fish on the spawning grounds, which are eaten by the ground-feeding fishes, such as suckers, mullets, redhorse, and in fact by all the aquatic life that feeds on the lake bottom; also those eggs which become covered with mud and silt and are smothered; the young fish eaten by the minnows during the early fry stage, and the fingerlings eaten by the larger fish. This loss can not be estimated, neither can it be controlled to any extent, but the greatest source of destruction, and one that can be controlled, is that which is carried on by mankind. This destruction should be divided into two classes, the economical and legitimate, and the unnecessary, wanton and criminal. By

the economical and legitimate we refer to the taking of those fish which have reached the age and size of maturity, the taking of which is or should be legalized by the state or federal laws, for as soon as fish of any species have attained their full maturity and have been given a chance to reproduce, the sooner they are removed from the waters in which they grew, the better it is for their own species. If left in these waters they consume the food that were better left for the consumption and growth of the younger fish. Therefore we have no quarrel with the fishermen who remove them, the dealers who by purchasing them encourage the taking, nor the laws of the different states which make such fishing legal. However, we can not too strongly condemn the wanton destruction of undersized and immature fish, such as are annually being taken from the waters of Lake Erie and placed upon the market. Although the present prices that are being paid for all kinds of fish are very tempting and make it profitable, just for the present, for the fishermen to bring them in just as small as they will be accepted, it is suicidal to his own business provided he expects to remain in the business two or more years longer, as will be shown later.

Most of the states bordering upon Lake Erie have laws regulating the size of most of the fish that may be legally taken, and as a rule the size limit is large enough, provided they are rigidly enforced, or conscientiously lived up to. But again, some of the most valuable species are not mentioned in the statutes of some of the states. For instance, of the four states bordering upon Lake Erie, Ohio has more coast line than all the others combined, and a far greater area of breeding grounds than all the others. This is especially true of two of the best and highest priced fish that are being produced, i. e. the whitefish and the pike-perch, and also they are the two species that are being propagated to the greatest extent, as a glance at the table giving the number of fry produced at the hatcheries will show.

We think, for this reason, the State of Ohio should have the most judicious and stringent laws possible for the protection of the young of these fish, yet one of these—one of the very best and highest priced food fishes taken in Ohio waters—has no protection whatever by the laws of the state which regulate the

size of the fish that may be legally taken, and in consequence tons of undersized pike-perch that would require from three to eight to weigh a pound can be seen on the market during both the spring and the fall fishing seasons. However, we would not be understood as censuring the fishermen, or even the dealers, too strongly for this great destruction of immature fish, as the very great demand and the high prices offered makes the temptation to offer anything that will be accepted on the market very strong. It is but natural to get all we can today without due thought for the future, and so long as there is no legal restraint placed upon them, we must expect the fishermen and dealers to follow the present custom.

As to whitefish, one of the best and highest priced of the fresh water fishes, it is fully protected as regards the size limit in the states of Ohio, New York and Michigan, the legal weight being two pounds in New York and Michigan and one and three-fourths pounds in Ohio. An experiment conducted by the writer showed whitefish of this weight were fully matured. Two hundred males and two hundred females were measured and weighed, with the following result: Males, 34 weighed 1¾ pounds, 78 weighed 1½ pounds; 74 weighed 2 pounds; 8 weighed 1¼ pounds, and 2 weighed 1 pound each. Females, 120 weighed 2 pounds, 56 weighed 2¼ pounds; 10 weighed 1¾ pounds; 8 weighed 2½ pounds and 6 weighed 1½ pounds each. This gives us an average of one and seven-tenths pounds each for the males and a trifle over two pounds each for the females. These fish were selected from about six thousand that were being held in pens; as the smallest fish were taken for the test, and all the males were found to be ripe, yielding milt freely, and the females were all heavy with eggs, so it was evident that they were all mature fish. If the size limits of these several states are not violated, the whitefish, in so far as size is concerned, is amply protected. Unfortunately this is not the case as the following incident will show: A fish dealer of Sandusky, Ohio, one day accosted the writer, saying that he had some fish at his fish house and would be glad to be advised as to what kinds they were, and upon examination they were found to be herring and young whitefish. Fifteen of these young whitefish were placed upon the scales and altogether weighed just

five pounds, an average of three fish to the pound. Although the herring, being fully matured, were in a fair state of preservation and still fit for food, the whitefish were so soft and mushy that they were entirely worthless and the dealer afterward informed me that they were all sorted out and sent to the reduction plant for fertilizer, and that just one-third of this fifty barrel shipment were these undersized whitefish. This is but one instance and one shipment.

The adult whitefish as they are taken in Lake Erie run about two and a half pounds to the fish, so that it requires eight hundred of them to weigh a ton. If the undersized fish are taken, those weighing a half or a third of a pound each, then it takes from four to six thousand of them to weigh a ton, for every ton of them placed upon the market there is an absolute destruction of from 3,000 to 5,200 fish in actual count. Moreover in many cases, as in the one cited above, they reach the market in a worthless condition and the makings of from five to six tons of the very best food fish have been totally destroyed without profit to any one. Nor is this all the destruction resulting from the taking of these undersized fish. It is but fair to assume that one half of them were females and as they were all taken while immature they have had no chance to reproduce. The destruction of eggs corresponds to the destruction of fish, and as the average number of eggs to the fish can be placed at twenty-five thousand, then for every ton of fish there has been destroyed from forty to sixty-five million of eggs.

In the case of the pike-perch we have still a greater destruction both in numbers of fish and eggs for the reason that the fish are placed upon the market smaller in size, requiring a greater number to the ton, and the average number of eggs to the fish is about four times as great, so that even though the fish be taken of the same size, the destruction of pike-perch eggs reaches the enormous number of from 160 to 260 millions for every ton of these immature fish placed upon the market.

Then there is the financial loss. If we place the price at ten cents a pound, the fisherman himself is losing from $320 to $520 dollars in weight alone for every such ton placed upon the market, and considering the difference in price between the small and the

full sized fish, his loss is still greater. The loss to the dealer is correspondingly large, as is also the food loss to the public. Although we, the Ohio hatchery people and ourselves, have produced during the last sixteen years enough fish to equal six times the number of minutes that have elapsed since the beginning of the Christian era, we can not hope to keep pace with the natural, the legal and economic, together with this wanton and criminal destruction. Now this being the case at a time when it behooves every one to conserve to the fullest extent every article of food, when every department of the government and all state officials are urging economy in the use of all kinds of foodstuffs and that every effort be put forth for the production of the same, surely some action should be taken by those in authority to prevent the continuance of this great waste of one of the most wholesome foods that nature has given us. As a preventative we believe the most efficient means would be the enactment of a universal law by all the states bordering upon Lake Erie and by Canada as well, such a law should fix a size limit on all fish of whatever species are taken for market and make this limit large enough so that every fish whould have reached maturity and had a chance to reproduce at least once before it would be legal to remove it from the water. But whether this or some other means is adopted, something should be done and that speedily or many of our best fishes will soon become so nearly extinct that it will no longer be profitable to follow fishing as an industry.

ADDITIONAL NOTES.

Undersized Herring.—Many of the herring caught on the Canada side this spring ran very small, as did also some that were caught on the American side. I was informed by one of the Canadian Fishery officials that, as late as July 30th, he saw herring that had been caught on the Canada side and shipped to the United States that would run from four to ten fish to the pound and some of them would weigh no more than an ounce each.

Length of Whitefish.—The average length of 200 male whitefish measured at Monroe, Mich., was 16¾ inches and of the females a fraction over 17 inches, and these were the smallest of a lot of six thousand.

Comparative Waste.—During the fall of 1911, in the district where the fish cultural work of the Ohio stations are conducted, there were taken 945,010 pounds of whitefish averaging about 2½ pounds each, or a total in numbers of 378,004 fish. Had the same number of pounds been taken of the undersized fish running three fish to the pound, it would have required 2,835,030 fish, which would mean a destruction of 2,457,026 fish, and if one half of these were females, as we have a right to suppose they would be, then there would have been a destruction of 6,087,575,000 eggs.

CONSERVATION AND PROPAGATION OF FISH IN THE UPPER MISSISSIPPI RIVER.

By Earl Simpson,
Winona, Minn.

In treating with this subject I wish to confine myself to that part of the Mississippi River extending from the vicinity of Prairie du Chien, Wisconsin, to St. Paul, Minnesota. As is well known, this territory of the river abounds in numerous small sloughs and lakes adjacent to the river, all of which are subject to overflow in seasons of high water. As we usually have periods of high water during the spawning season of the fish that are habitat to the upper river, it results in the fish going to these numerous lakes, sloughs and pockets adjacent thereto, and later on, as the water recedes, they are left there in what we term "dead pockets," and unless rescued and placed in the river they die.

The fish abounding in the upper waters of the river, other than the commercial fish, are the small-mouthed black bass, pike, sunfish, catfish, crappy and pickerel.

In 1914 the first systematic work in rescuing these fish was commenced along the river, and in the beginning necessarily was limited in extent, but the results derived even from the small amount of work done clearly showed to those interested the great possibilities that might be attained along this line. At first the work was limited to the members of the Winona County Fishermen's Association. Then the Latsch Board, who control numerous bottom lands adjacent to Winona, became interested in the work and, finally, the United States Bureau of Fisheries Station at Homer, Minnesota, took up the work. During the season of 1916 practically all the dead sloughs and pockets in the territory extending from Trempealeau, Wis., to Minneiska, Minn., about thirty miles in extent, were seined and the fish placed in the main river, with the exception that a small per cent. were retained by the Government and used in stocking the numerous lakes and rivers in Minnesota and Wisconsin. It is estimated that at least five million game fish were saved through this work, and the greatly improved condition of the fishing in the vicinity

of Winona during the past season has clearly shown the wisdom of this policy. We feel that if the other cities, located in the territory in which this work could well be undertaken, would interest themselves in this matter, it would be but a short time until the upper waters of the Mississippi would become the finest fishing territory imaginable.

Restocking the river in this manner is different from the ordinary methods adopted in restocking streams and lakes, in that the extent of transportation of the small fish is practically nothing. The fish are taken in the seine directly from these pockets to the river, or placed in pails and tubs and transported quickly, so that there is practically no loss from this source. If these fish are once placed in the deeper water, even though we do have higher water level in the season, they do not go back to the sloughs and pockets, but care for themselves in the deeper water. The expense involved is very small when we take into consideration the results obtained. A crew usually consists of three men, a small launch, a seine and a few tubs and pails. Two men operate the seine and the other transports the fish. It is estimated that such a crew will rescue one hundred thousand fish a day.

Even though the dead sloughs and pockets do not entirely dry up and the fish live through the summer season, these small bodies of water will freeze to the bottom in the winter following and the fish will be destroyed in this manner.

While considering this matter, I feel it my duty to call the attention of this body to the lack of a fishway in the Keokuk Dam, located at Keokuk, Iowa, on the Mississippi. There can be no question that several species of the fish that inhabit the upper river migrate south during the fall and early winter, and once they go over the Keokuk Dam it is practically impossible for them to get back up the river the following spring. It has been said that the river below the dam at Keokuk is just alive with fish, during the spring, trying to get back to the upper waters of the river. This condition prevails especially with reference to the skipjack, which although not a food fish, is very useful in the upper river as food for the pike. Up to the time of the construction of the Keokuk dam it was a common saying along the river, that wherever you saw the skipjacks working you could

feel certain that the pike were lying below the ends of the dams and reefs where these fish were working and were feeding on the minnows that were stung by the skipjacks.

During the past three years there has not been a skipjack seen in the upper river and, as a result the pike have had a hard time to find sufficient food. They are now caught, whenever it is possible to catch them, along the shallow flats or bars, where they evidently are searching for food.

I have been told that the Keokuk dam is one of three dams in the United States which have been constructed under government supervision without requiring the construction of a fishway, the other dams being located in the western states. It would seem that this society should adopt a resolution or memorial to Congress requesting the construction of a proper and suitable fishway in the Keokuk dam, so as to permit the fish of the Mississippi to obtain free access to the upper and lower sections of the river.

FISH CULTURAL ACTIVITIES OF THE FAIRPORT BIOLOGICAL STATION.

By Austin F. Shira,
Director of the Station.

While the work of the United States Fisheries Biological Station, Fairport, Iowa, is known primarily for its service in connection with the propagation and investigation of fresh-water mussels, its field of activities is quite broad and includes in its scope various fishery problems of a specific or general nature. This multiform functioning is clearly stated by Dr. R. E. Coker in his recent article descriptive of the Fairport Station.* For present purposes the work may be conveniently divided as follows: 1. Mussel Propagation; 2. Fish Propagation; 3. Associated Activities. The first and third will not be dwelt on at length here, but in passing it will be stated that under the former are included both the practical and experimental phases of artificial mussel propagation.

My object at this time is to present to you some of the less familiar activities of the station grouped under the second heading. This heading may be further sub-divided into (a) Intensive pond culture; (b) Artificial hatching in jars; (c) Studies of natural food, and (d) Experiments in artificial feeding of river fishes.

(a) *Intensive Pond Culture.*—The pond cultural experiments have been designed to augment our knowledge of the conditions most conducive to increasing the productivity of small ponds on farms or elsewhere. In order to accomplish such an end, it is of course quite necessary that the problem be attacked from the small pond owner's point of view to some extent. The possessors of small ponds desire to have their ponds well stocked with fish, primarily for the meat furnished the table and also for the sport afforded in catching them. The farmer is a busy man; but he is beginning to realize more and more that recreation as well as a greater variety of diet makes for increased energy and efficiency. The fish pond helps to meet these requirements, by furnishing sport on the one hand and acceptable food on the other.

*Robert E. Coker: The Fairport Fisheries Biological Station—Its Equipment, Organization and Functions. Bureau of Fisheries Document 829.

However, the time has not yet come when the pond owner will give any considerable attention or care to the pond, and any results that may reward his slight efforts are largely due to naturally favorable conditions. It behooves us then to attack from this view-point in order that we may supply the information for meeting the present demand, while at the same time we are gathering data for an educational campaign for the better care and utilization of small ponds for increased production.

Accordingly, experiments are being carried on to furnish information as to the best combination or combinations of fishes for best results, and the greatest number of fishes a pond of given size can support for an optimum growth, with and without artificial feeding. In one of our ponds (0.224 acres in area) originally stocked in 1914 with adult large-mouth black bass, crappie and bluegills, the bluegills have practically taken possession of the pond. The experiment was permitted to run along for a period of three years without an increase or decrease in the stock, save by natural causes, but an inventory was made each fall. Originally stocked with 30 large-mouth black bass, 45 crappie and 40 bluegills, this pond yielded a total of 103 bass, 12 crappie and 3,945 bluegills when drained in the fall of 1916, after having run for three seasons. This year the number of bluegills was reduced to 1,500 and the experiment carried on as before except that since July 1 five pounds of fish are taken from the pond weekly. The object is to determine whether or not such a pond when once well stocked will be self sustaining when subjected to regular fishing.

Experiments in the rearing of large-mouth bass together with bluegills have been carried on for comparison with the results obtained with bass alone. While no final and conclusive statement can be made, the indications are that the best results can be obtained with bass alone. This year we are carrying on additional experiments with bass and the orange-spotted sunfish together. In another pond we are carrying over yearling bass, bluegills and buffalofish. The logical combination would seem to be such fish as the bass, crappie and bluegills, with some form that feeds largely on the bottom, such as the bullhead, buffalo or golden shiner. Within a few years we hope to be in position to give some very definite information relative to the kind and number of fish best suited to a pond of a given type and area.

Bass, crappie, sunfish and bullheads are the fish ordinarily used in stocking small ponds, but in view of the demand for fishes that reach a larger size attention has been given to two other fishes as possibilities for this purpose; namely, the buffalofish of the genus *Ictiobus* and the channel catfish, *Ictalurus punctatus*. The European carp should also come in for additional attention in this regard.

Experiments with the buffalofish were started in the spring of 1915, with young fish artificially hatched in Downing jars. One hundred and eighty thousand fry were placed in a small earth pond and later transferred to a pond of about one acre in area. In the fall this pond yielded about 50,000 fingerlings, varying in length from one to six and one-half inches. While this is not a phenomenal growth it was very encouraging when consideration was given to the fact that the pond was new and devoid of vegetation. Thirteen fish that had been placed in a small pond containing abundant vegetation had reached an average length greater than six inches. The rearing of these fish has been continued and this year at an age of two years some of the fish retained had reached a length of seven and one-half inches. Additional fish were hatched last year and this year and further experiments are being carried on. This season two ponds have been devoted to yearling buffalo, about 1,000 per acre in one and about 3,000 per acre in the other. These fish are being fed partially on artificial food and good growth is being made. In two other ponds of equal size, fry were placed, 2,500 in one and 6,500 in the other. These fish are subsisting wholly on natural food and though considerable loss has been sustained, presumably caused by parasitic trematodes, the surviving fish had reached an average length of about two inches by July 12, at an age of about two months.

What we consider one of the greatest achievements is the fact that we have succeeded in inducing the buffalofish to spawn in one of the ponds. This was tried last year, but without results. The same brood stock, augmented by additional fish taken from the river this spring, was placed in an earth pond of about an acre in area. In order to simulate natural conditions to some extent, the pond was only partially filled with water when the fish were introduced and the water level was gradually raised at

the approach of the spawning season. The fish were first seen "splashing" May 11 and later on May 17, 18 and 19. The first young were seen May 26. The present indications are that the pond is over stocked, judging by the size of the fingerlings (1½ in.), as compared with the fingerlings (2 in.) in the two ponds mentioned above.

The success obtained last year in hatching and rearing young channel catfish, *I. punctatus*, in a pond at the station was described in a paper published in the Transactions of this Society for March, 1917.*

This season two small earth ponds are being devoted to some of the young reared last year, in order to obtain additional data on the growth. In one pond were placed 108 of the yearling fish with natural food only and in the other 464 fish to be fed in part on artificial food. The growth has been quite substantial and some of the fish have now reached a length of about 6 inches.

An additional hatch of young catfish was obtained in the same pond again this year.

From a stock of red-eared sunfish, *Eupomotis gibbosus*, placed in an earth pond last season, a brood of young was obtained. It may develop that this species will be quite suitable for raising with large-mouth black bass, as it is more of a bottom feeder than perhaps any other sunfish and spawns quite late, the young thus being available as food for the young bass. Young sunfish of the species *L. euryorus*, the habits of which were but little known, were also hatched in one of the ponds. The comparatively rapid growth and uniform size of the young lead one to believe that this may be a very suitable species for small ponds.

(b). *Artificial Hatching in Jars.*—In connection with the pond cultural work, experimental hatching of various river fish has been carried on to some considerable extent. As stated above, the work was first undertaken in 1915 when a hatch of 1,723,625 buffalofish was obtained. The work in the two succeeding years resulted in a hatch of approximately ten millions in 1916, and seven millions in 1917. The eggs were obtained primarily at New Boston, Ill., and as the fish from which they were taken were caught by the commercial fishermen for the market,

*Notes on the Rearing, Growth, and Food of the Channel Catfish, *Ictalurus punctatus*. Tran. Am. Fish. Society, for March, 1917. Vol. 45, No. 2.

the hatch represents a clear gain as the eggs would otherwise have been lost. The total cost of hatching and planting the fish the past season was slightly more than seven cents per thousand, including over-head expenses and the salaries of permanent employees actually engaged. It may be safely said, then, that the work is now on a practical and well established basis.

In view of the increased demand for additional cheap food fishes to supplement the meat supply of the country and aid in reducing the high cost of living, experimental hatching of the European Carp, *Cyprinus carpio*, in jars was undertaken this spring. Approximately 112,000 fry were hatched and liberated in the Mississippi River. Several thousand reserved for additional experiments, were placed in one of the ponds and a very marked growth has been made.

Some work was also done last year on the Missouri Sucker, *Cycleptus elongatus*, and 83,000 fry hatched in jars were planted in the Mississippi River. This is a very good food fish and commands a price almost equal to that of the buffalofish.

(c). *Studies of Natural Food.*—No work in pond-fish culture would be complete without a thorough knowledge of the natural food taken by the fish under varying conditions. This information is being obtained by intensive food studies carried on by both regular and temporary employees. Weekly collections of young fish are made from each of the ponds throughout the summer and fall for food examinations and the kind and quantity of food taken is compared with the available supply in the pond. Interesting and valuable data, indeed, are being accumulated. For instance, we have found that the very young buffalofish subsist largely upon rotifers which are taken in large numbers, later turning to Chironomus and other insect larvae and Entomostraca. The stomach examinations reveal the fact that all the young fish feed generally and with but little discrimination on the prevailing food of the ponds, as the proportion of the various items constituting their diet are comparable to the proportionate abundance of their occurrence in the ponds. These studies also serve as an index of the food required for optimum growth. A few examinations made last year indicate that it is desirable to continue making the collections to some extent throughout the winter so that more complete data will be at hand.

(d). *Experiments in Artificial Feeding of River Fishes.*—In order to supplement the work carried on in the ponds, artificial feeding experiments are in progress this year with fish held in troughs and tanks. In order to have clear water at all times the supply for these troughs is taken from one of the earth ponds, the water of which scarcely becomes roily even during the periods of the greatest turbidity of the Mississippi.

The fish which are being used in these feeding experiments are: fingerling, yearling and two year old buffalo-fish, fingerling and yearling channel catfish and fingerlings of the European Carp. The food consists of meal, dried and ground mussel meats, beef liver, cheese and ground table scraps. The amount of food fed the fish daily is weighed and notes of the weekly increase in weight and size are recorded.

Another phase of our work is brought out in the co-operative plan instituted this spring with the Crystal Lake Club, of Burlington, Iowa. This Club owns a lake of about 1,200 acres in the Illinois lowlands opposite Burlington and is interested in increasing the productivity of the water by propagation. Accordingly we are working with them, have diked and screened off small areas of the lake as breeding grounds and have stocked them with bass, crappie and sunfish. Evidence is already at hand indicating that a good hatch has been obtained.

This lake has been formed in the levee district and is wholly cut off from the river, except that water may enter through a 12-inch pipe at a 7 ft. stage of the river. This lake is quite typical of other conditions along the Mississippi and Illinois Rivers and the results that may be obtained by our efforts should be applicable to other places. While this co-operative work is concerned with game fishes the same scheme should be applicable to other food fishes as the buffalo, catfishes and carp.

ADDITIONAL NOTES ON REARING THE CHANNEL CATFISH, ICTALURUS PUNCTATUS.

By Austin F. Shira,
Director, U. S. Biological Station, Fairport, Iowa.

Last year a paper was prepared for presentation before this Society giving in considerable detail the results obtained in rearing the channel catfish in one of the ponds at the Fairport Biological Station. As these results constituted the first detailed record of the breeding of this fish in ponds, you will be interested in a brief account of the supplemental work done this year.

It was very unfortunate that the conditions last year necessitated the drawing of the pond to determine whether or not the catfish had spawned. In order to avoid this, most of the kegs to be used as nests this year were provided with an opening in the side about 7 x 5 inches, with a closely fitting hinged cover, so that when placed in a horizontal position in the pond, the interior could be examined by simply raising this cover. All kegs except a few buried in the bank were securely fastened to posts so that little disturbance resulted when examination was made. Twenty kegs in all were placed in the pond, fifteen of which were provided with side openings and covers. Three without openings were placed in a horizontal position in the pond bank with the mouth outward.

Several of the kegs were placed with the top within a foot of the water surface. As the water in the pond became clearer with the advance of the season, the interior of the kegs so placed could be observed without great difficulty from the pond bank when the covers were raised. On examining the deeper kegs, however, it was necessary to use a water-glass.

The brood stock numbering 40 individuals was placed in the pond May 23, 1917. From July 1 until after the spawning season the pond was subjected to frequent observation by the Superintendent, Mr. H. L. Canfield, and others.

The first eggs were discovered July 12 in one of the kegs placed within a foot of the water-surface. The nest was again

examined July 14, and at intervals the parent fish was observed "fanning" the eggs by gentle movements of the tail and fins. This fanning or care of the eggs was continued while the cover of the keg was raised and while an attempt was being made to photograph the nest. Samples of the eggs then taken from the keg with a glass tube and rubber bulb, showed well developed and active embryos.

The eggs were removed from the keg and the mass divided as evenly as possible in halves, one half being retained and the other half returned again to the keg. During the process of dividing the egg-mass, hatching commenced and before arrangements for taking a photograph of the eggs could be made, all had hatched. However, a photograph of the fry was obtained.

An actual count gave a total of 2,945 active and vigorous fry. Including the few dead eggs and a few fry that died, the half of the egg-mass contained 2,972 eggs. Allowing for a slight unequal division of the eggs, the original mass found in the keg contained approximately 5,944 eggs, quite a respectable number when the large size of the eggs is taken into consideration. The young were placed in a trough outdoors to be subjected to the artificial feeding experiments.*

Ten other nests were carefully examined, one of which bore evidence of having been cleaned and two others appeared as though fish had been frequenting them, but nothing definite could be determined. One keg examined July 17, appeared to contain young fish, but further investigation was not made until the following day when 284 were obtained. The top of this keg was 31 inches below the water surface. The small number found in this nest may have been the remnant of a brood the larger portion of which had left the nest earlier. These young fish were also placed in an outdoor trough for artificial feeding experiments.*

We were especially well pleased to get a hatch in the pond again this season and with this start hope and expect to obtain more substantial results next year. While it is yet too early to draw conclusions, the data already secured point to the channel catfish

* When this pond was drained October 21, 1917, young fish to the number of 5,942 were obtained, making a total of 9,171 young catfish for the season.

as a very promising fish for pond culture. The fact that it is easily fed, taking artificial food with avidity, is much in its favor. While it will perhaps not reach a maximum size under ordinary small pond conditions a weight of several pounds should not be considered at all unusual. The growth experiments now in progress will yield very valuable and pertinent information regarding this.

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TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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PROCEEDINGS

of the

Forty-Seventh Annual Meeting

of the

American Fisheries Society

ST. PAUL, MINN.,

August 29, 30 and 31, 1917

Opening Session*, Afternoon, August 29th.

The meeting was called to order by the President, Dr. George W. Field, who presided throughout the sessions.

REPORT OF THE RECORDING SECRETARY.

Mr. Carlos Avery, of St. Paul, Minn., Recording Secretary, submitted as his report the Proceedings of the Forty-sixth Annual Meeting held at New Orleans, La., as published in the June, 1917, number of the TRANSACTIONS.

It was moved and carried that the report be accepted.

REPORT OF THE TREASURER.

The report was read by Secretary Avery, who prefaced the reading by the statement that, following the death of Mr. Chas. W. Willard, who had acted as Treasurer since 1900, Miss L. B. Rimbach, of Medford Hillside, Mass., was made Acting Treasurer. Miss Rimbach's report covers the period from the annual meeting of 1916 to August 11, 1917, and is as follows:

* On the morning of the twenty-ninth the Society met with the National Association of Fish and Game Commissioners, at which time addresses of welcome were presented by the Governor of Minnesota and the Mayor of St. Paul.

To The American Fisheries Society:

I herewith submit my annual report as Acting Treasurer from the meeting in October, 1916, to the 11th of August, 1917.

RECEIPTS.

Sale of Transactions		$ 113.09
Interest on deposits and fees for collection on checks received from members		6.28
Annual dues:		
For year 1912	$ 4.00	
For year 1913	4.00	
For year 1914	40.00	
For year 1915	73.00	
For year 1916	710.00	
For year 1917	566.00	
For year 1918	10.00	
For year 1919	2.00	
Total dues collected		$1,409.00
Total		$1,528.37

DISBURSEMENTS.

Per Cash Book:

1916				
At Oct. meeting, Rexford L. Holmes, on account of bill for reporting			$25.00	
Dec.	5	Postage stamps (Voucher 1)	1.00	
	19	Express on package from C. W. Willard Co	.45	
1917				
Jan.	11	Postage stamps (Voucher 2)	2.00	
	11	Cash book	.50	
	15	Rexford L. Holmes (on account)	50.00	
	16	Stamped envelopes (Voucher 3)	21.00	
	16	Rubber Stamp (Voucher 4)	.65	
	17	Rubber stamp (Voucher 5)	.30	
Feb.	2	M. Riddell (mimeographing and addressing)	7.88	
	12	Rexford L. Holmes (balance on bill Voucher 7)	75.00	
	21	Clark & Fritts, Sept. Trans. (Voucher 8)	107.41	
		Exchange on January checks	.10	
		Exchange on February checks	.50	
April	2	The Leader Prtg. Co., (letterheads) (Vouch. 9)	19.58	
	7	Exchange on March checks	.20	
May	1	Estate of C. W. Willard, (Voucher 10)	187.71	
	1	Exchange on April checks	.20	
	4	Stamped envelopes (Voucher 11)	4.30	
	5	Clark & Fritts Dec. Trans. (Voucher 12)	167.84	
	16	Stamped envelopes (Voucher 13)	6.44	
	18	J. C. Hall Co., Receipts for 1918 (Voucher 14)	5.08	
	22	Clark & Fritts Mar. Trans. (Voucher 15)	149.59	
	24	M. Riddell, Circulars (Voucher 16)	3.00	
		Exch. May checks, 10c.; June, 10c.; July 20c	.40	
July	23	Leader Printing Co., printing	22.00	
				864.13
Balance per Cash Book				$664.24

L. B. RIMBACH,
Acting Treasurer.

Medford Hillside, Mass., Aug. 11, 1917.

REPORT ON PERMANENT FUND.

To the American Fisheries Society:

In regard to the Permanent Fund of the Society I have to report that this still remains on deposit with the Industrial Trust Co. of Westerly, R. I., and that since the report made by Mr. C. W. Willard at the meeting of the Society in October, 1916, there have been no deposits in or withdrawals from this fund.

Mr. Willard's last report showed a balance on October 9, 1916, of $2,799.56.

L. B. RIMBACH,
Acting Treasurer.

Medford Hillside, Mass., Aug. 11, 1917.

Moved and carried that the report of the Treasurer be referred to the Auditing Committee for the usual verification of the accounts.

President Field announced the appointment of the following Committees:

Auditing Committee: Messrs. F. A. Tulian and Geo. H. Graham.

Committee on Resolutions: Messrs. W. A. Killian (chairman), E. A. Hinshaw, J. H. Kirk, E. G. Bradford, J. Q. Ward, Wm. E. Barber, and H. B. Ward.

Committee on Nominations: Messrs. J. W. Titcomb (chairman), John P. Woods, M. L. Alexander, J. Q. Ward, Seymour Bower, Eben W. Cobb, and H. S. Hedrick.

Committee on Time and Place of Meeting: Messrs. A. L. Millett (chairman), John M. Crampton, Theo. Roualt, A. Eastgate, D. G. Beauchamp, Linus Leavens and Henry O'Malley.

Committee on Publication: Messrs. R. C. Osburn (chairman), Bashford Dean and John T. Nichols.

Committee on Membership: Messrs. John W. Titcomb (chairman), Seymour Bower, Eben W. Cobb, S. P. Wires and S. P. Bartlett.

Committee on Program: Henry B. Ward and Henry O'Malley.

In announcing the Membership Committee, President Field called attention to the importance of increasing the membership. "There has never been a time in the history of the nation or of the world when constructive work on fisheries in the laboratories and

hatcheries, with county and state commissioners, state legislatures, Congress and the Bureau of Fisheries, has been so much needed. It will be the duty of the Membership Committee to canvas the situation, to interest all the newcomers and to encourage any past members who have dropped out to renew their membership. But in addition to this every member of the Society should constitute himself a membership committee of one to see that his friends and associates are informed as to the work of this Society and their support and interest secured."

Mr. E. A. Tulian, of Louisiana, was elected Acting Treasurer to serve during the meeting.

ELECTION OF NEW MEMBERS.

A list of applications was presented and, upon vote of the Society, the following members were declared elected to membership:

Honorary Member.

HONORE MERCIER, Minister of Colonization, Mines and Fisheries, Quebec, Canada.

Life Member.

GEORGE D. PRATT, Conservation Commissioner of New York, Albany, N. Y.

Active Members.

ACKERKNECHT, CHAS. H., 872 Selby Ave., St. Paul, Minn.
AINSWORTH, G. G., Manchester, Iowa.
ALLEN, CLARENCE J., Box 738, Milwaukee, Wis.
ANDERSON, DR. F. E., Red Wing, Minn.
ANNIN, H. E., Margaretville, Del. Co., N. Y.
BARNEY, RAYMOND L., Homer, Minn.
BEAUCHAMP, D. C., Game and Fish Commissioner, Paragould, Ark.
BLAIR, FRANK D., Excelsior, Minn.
BLOOM, J. H., Game and Fish Commissioner, Devils Lake, N. Dak.
BROWER, J. F., Fish and Game Commission, Holmesburg, Pa.
BURKE, WM. H., Old Forge, N. Y.
BURKHART, JOE, Lewis, Wis.
CALDWELL, F. M., 2311 Carter Ave., St. Paul, Minn.
CANFIELD, H. L., Fairport, Iowa.
CHAMBERLAIN, W. R., Game Warden, Wabasha, Minn.
CHAMBERS, E. T. D., Dept. Colonization, Mines and Fisheries, Quebec, Canada.
CLEASBY, E. A., 900 Camerson St., Eau Claire, Wis.
COOK, WARD A., U. S. Bureau of Fisheries, Duluth, Minn.
COWDEN, S. M., Conservation Commission, Albany, N. Y.
CRESS. H. A., Booth Fisheries Company, St. Paul, Minn.
CURRAN, JOHN L., Commissioner of Inland Fisheries, 602 Grosvenor Bldg., Providence, R. I.
DAVIDSON, HENRY, Fish Hatchery, Bath, N. Y.
DESAUTELS, H. E., Cedar Island Lodge, Brule, Wis.
DUNN, ANDREW C., Northern Fish Co., Duluth, Minn.

Eastgate, Alfred, St. John, N. Dakota.
Erickson, C. J., 328 Washington St., Boston, Mass.
Farrington, Ray G., Ortonville, Minn.
Fisher, A. K., U. S. Biological Survey, Washington, D. C.
Fitzgerald, E. J., Minneiska, Wis.
Gibb, C. D., Game Warden, Wilder, Minn.
Gorham, W. B., Brook Trout Co., Hudson, Wis.
Green, J. C., 4730 London Road, Duluth, Minn.
Gunther, F. E., 420 S. 5th Street, LaCrosse, Wis.
Hill, Howard Rice, 1108 W. Illinois St., Urbana, Ill.
Johnston, J. W., Box 578, Rochester, N. Y.
Jensen, Harold, State Fish Hatchery, St. Paul, Minn.
Keyes, H. W., Ranier, Minn.
Killian, Wm. H., 572 Munsey Bldg., Baltimore, Md.
Kirk, J. H., State Fish and Game Commission, Bottineau, N. Dak.
Komoll, C. F., Dundas, Minn.
Lau, H. C., Star Prairie, Wis.
Lawyer, Geo. A., U. S. Biological Survey, Washington, D. C.
Leavens, Linus, Fish and Game Commission, Cambridge, Vt.
Leopold, Aldo, Forest Service, Albuquerque, N. Mex.
MacLachlan, Dr. Chas., President Game and Fish Board, New Rockford, North Dakota.
Mack, John E., Carson City, Nev.
Miller, Albert P., Constantia, N. Y.
Miller, Dan E., Constantia, N. Y.
Monker, C. C., Grand Marais, Minn.
Nelson, J. O., Glenwood, Minn.
O'Brien, J. P., Box 1, Reno, Nevada.
Otis, Milo F., State Fish Hatchery, Upper Saranac, N. Y.
Packer, Arthur, 423 Plymouth Bldg., Minneapolis, Minn.
Pinkerton, J. A., Glenwood, Minn.
Rasmussen, Dr. A. T., LaCrosse, Wis.
Reynolds, O. J., Game Warden, Alexandria, Minn.
Richtman, S. P., Fountain City, Wis.
Risley, A. F., State Fish Hatchery, Linlithgo, N. Y.
Roualt, Theo., Jr., State Game Warden, Santa Fe, N. Mex.
Seiz, B. F., Deputy Game Warden, Red Wing, Minn.
Selvog, Hans R., Warroad, Minn.
Smith, G. A., Commissioner of Fisheries, Oklahoma City, Okla.
Sportsmens Review Publishing Co., 15 W. 6th St., Cincinnati, Ohio.
Ward, Robertson S., 172 Harrison St., East Orange, N. J.
Watts, A. E., 9 T. Wharf, Boston, Mass.
Welsch, H. N., Box 4, Salt Lake City, Utah.
Williams, J. A., State Board of Health Bldg., Tampa, Florida.

Mr. John W. Titcomb called for an explanation of the Permanent Fund of the Society, and Prof. Henry B. Ward stated that it resulted from the fifty dollars contributed by each of the Patrons of the Society, of whom there are fifty-three. Only the interest of the fund derived from this source may be used.

Mr. Titcomb also brought up the question of publishing the index to the first forty volumes of the Transactions, prepared by Mr. Daniel B. Fearing, but no action was taken.

On motion by Mr. John P. Woods the Session adjourned.

Wednesday Evening Session, August 29th.

The American Fisheries Society met in joint session with the National Association of Fish and Game Commissioners, as the guests of the Local Committee. A series of moving pictures, showing the winter elk range in the Jackson's Hole country, Wyoming, was presented by Mr. Norman McClintock and explained by him.

Mr. McClintock stated that the pictures were made by assistance from Hon. George Shiras, 3d, of Washington, D. C., and the United States Biological Survey. The photographs were taken with a telophoto lens and a series made by the ordinary method was shown to indicate the difference. The Jackson's Hole game refuge was visited in February and involved a trip over the Teton mountain range by sled from the railway terminus at Victory, Wyoming, over six feet or more of snow. The elk were shown, more than 3500 in one herd, at the winter feeding grounds where hay is provided to keep them from starving to death.

Other reels shown by Mr. McClintock illustrated a herd of 500 antelope in the Yellowstone National Park; also mule deer, mountain sheep and the peculiar little aquatic bird known as the water ouzel.

Hon. M. L. Alexander introduced Mr. Stanley C. Arthur, ornithologist of the Department of Conservation of Louisiana, who presented a series of pictures illustrating ducks and geese in winter time in Louisiana. Gulls were also shown on the reserves, which are under the protection of the Federal Government and the Audobon Society, in co-operation with the State of Louisiana.

Mr. Alexander also introduced Mr. Marshall McLean, of the New York Conservation Commission, who explained a series of pictures showing the work of the Commission. These reels were made to familiarize the people of New York State with the operations of the different branches of the State Commission. The purpose of this, Mr. McLean explained was to educate the people in conservation, in order that the Commission might have the full support and sympathy of all classes of the people.

The evening session was then adjourned.

Thursday Morning Session, August 30th.

PRESIDENTIAL ADDRESS.

BY DR. GEORGE W. FIELD.

It has been my good fortune to spend the past three months in Colorado, Oregon, Montana and Wyoming, and I have been impressed with the importance of the development of fisheries work in that section of the country. Everywhere, all over the country, the importance of fisheries as a national problem is increasing very rapidly. The general utilization of fish as food, fertilizer and oil is at present handicapped, among other things, by a lack of individual responsibility, by divided or even entire absence of legal authority, by selfishness on the part of individuals and by lack of knowledge and foresight. This results in enormous wastage in all directions.

Have you considered how many fish are thoughtlessly killed by anglers (not sportsmen) who catch a large number of fish and fail to utilize them? The aggregate is astounding. It is a small matter for a party to go out and catch a dozen, thirty, fifty or more fish of various kinds which are edible, but how many of these are left unused and forgotten in the boats or otherwise wasted? On both the west and east coasts and to a certain extent in the rivers, a very large number of fish below the market size are caught and killed. This particularly occurs on the New England coast where the fishermen still make a business of catching small mackerel, pollock and other smaller fish, counting about 900 to the barrel. They get on the market forty cents to a dollar for those 900 fish. If these were allowed to grow to maturity they could get from twenty-five to thirty-five or forty cents apiece for them. We have made some rough computations and found that forty cents worth of such small fish, in one year, possibly, or in two at the outside, might amount to $280.00 worth of food by natural growth, after allowing for a decrease of 50% in numbers. But more than that, under this unwise method of catching schools of small fish by traps and seines, a very large proportion of these are thrown overboard as of no market value.

Reforms of this kind which affect the pocketbooks of fishermen are difficult to bring about, but they are exceedingly important in

the general economy of the nation. I believe that the conditions that obtain now, when the people are going to look into these practices on account of the necessities of war, will make very largely for improvement.

We found, as a general proposition, that in the fisheries business as conducted in a great many places, at least 40% of the total product is wasted; never gets to market, never utilized for food, never turned into cash in any way, shape or fashion. Now I do not know of any greater arraignment of any industry than to say that there is a 40% waste. What would it mean to the country and to the world if there were that waste in the grain trade or in the handling of meat supplies. It is a national disgrace that such a condition obtains anywhere in the United States.

There is also an enormous curtailment of the fish supply and particularly of the breeding grounds. This comes about through the introduction of sewage into public waters. Factory wastes entail an enormous loss, not alone to the fish, but particularly to the industries themselves. I have had a recent report of one of our rivers which was formerly an important salmon and shad river and could be utilized for many other species of fish. That river, the Merrimac, was practically wiped off the fishermen's map on account of the pollution by factory and municipal sewage. The report states that the factories, particularly the woolen factories, are equipping their mills with devices for saving wool scouring wastes. Already there has been a very marked improvement in that river and we may look in the near future to its becoming again a source of food and recreation to the people. Now that must be done ultimately in practically every large river of the country. One cannot traverse any of the large rivers without noticing a large amount of waste going on unnecessarily. This is true, not alone of the rivers of the east where the condition has grown worse through years of malpractice, but the rivers of the central part of the country and of the west are rapidly getting into that condition.

I was astounded at the changes made in the rivers by mining operations in Nevada, Northern California and Oregon. Some of this can be avoided. Lumbering operations, too, throw enormous amounts of useful waste into the streams because up to the present time we have not been obliged to utilize those types of materials.

There is another chance to make an enormous saving of fish life in our irrigation operations. You are all familiar with the fact that when the gates of the irrigation systems are opened enormous quantities of fish of all sizes go into the ditches and as the water dries up the fish, of course, are left there and wasted. Every state which has irrigation projects within its borders should be compelled by public sentiment to utilize those fish in some way. By systematic collections they could be used for stocking ponds or rivers and then, occasionally, the best of the fish might be put on the market. Those which are below market size should be put in ponds for future use. A systematic collection would be relatively easy if wells or pockets could be constructed, so that as these irrigation ditches dry up, the fish would gradually collect in these deep places where they could be systematically handled.

In regard to the fish screen, it is still necessary to find some practical, usable, non-clogging screen and to educate the people to its use. I know from personal contact with the authorities of the United States Reclamation Service, that they stand ready to forward any well-devised movement in that line.

The salvage of fish from overflow of rivers has been in operation to some extent in parts of the country, but there is still much waste where this important opportunity is neglected. It has been carried on by the Bureau of Fisheries and by some states for a number of years, but must be extended to other localities. It is important also, that advanced steps should be taken relative to the methods and the necessity of developing and utilizing the full producing powers of public and privately owned waters, not as a temporary, but as a permanent source of food and recreation.

The state universities should be called upon by the people to give more extended instruction in aquatic biology and in related chemistry and physics and in all problems involved in the complete utilization of the water and of the fish for food and recreation, and should closely scrutinize existing and proposed laws to eliminate biological blunders. At various times this has been urged by Dr. Smith, the U. S. Commissioner of Fisheries, and some of the state universities are already working on these lines, but there must be a wide extension.

One of the most important applications of biology and of science, I believe, is in educating the legislatures as to the import-

ance of these things. They should be encouraged to promote more extensive development of fish cultural operations, both in public waters by special concessions and particularly in private waters under beneficial laws by public and private capital. It is possible in many projects, where the waters are now used for the irrigating of land, to interpolate ponds in these irrigation systems where the water could be used for rearing fish and then passed on from the fish ponds into the ditches to irrigate the land in the usual manner. The person who may wish to develop ponds frequently cannot afford to put in a permanent and satisfactory water supply at his own expense, but the great reservoirs of the United States Reclamation Service might in many cases be utilized, after the requisite legislation has been enacted and the proper regulations made for supplying fish ponds. It would mean a tremendous extension of the wise utilization of this water for producing food. In the case of the irrigation projects, this double utilization of water would mean an additional source of income, as the owner of the fish pond could afford, as well as the person irrigating the land, to pay a reasonable sum for the use of the water.

Improved methods of distribution and marketing fish are still imperatively necessary, in spite of the fact that great progress has been made in the past five years. Enormous quantities of shrimp, lobsters and crabs, among the shell-fish, and of all species of fish, are still wasted. Of this you need no better evidence than can be found in any of the fish markets in the large cities. Even within twenty-four hours of the mouth of the Columbia River, I was warned that it was positively dangerous to eat fish on any day except Friday or Saturday, for the reason that the supply came in only on Thursday night. On Friday and Saturday it was safe, but after that there was positive danger of ptomaine poisoning. That is within twenty-four hours of the supply of a main original source of salmon, halibut and Pacific cod; and more than that, it is in the center of an area abounding in mountain streams and extensive lakes.

It is perhaps unnecessary at this point to speak of the importance of state and federal hatcheries and rearing ponds on public waters. There should be an extension of methods of practice of caring for the ripe fish caught for market both on the lakes and on

the Pacific and Atlantic coasts. There should be increased utilization of the fish wastes.

I believe the most important biological problem of the nation today is the destructive effect of immense drainage projects carried out at the instigation of petty lawyers and promoters seeking to make profit for themselves. They are entirely neglectful of the great damage resulting from the enormous amount of flood water which is turned into the streams prematurely by draining swamps and lakes in addition to the normal run off. Much of the benefit arising thus from the extension of agricultural areas is negatived by the destruction wrought by flood or drought. Unwise drainage operations may even tend to hasten the progressive drying up of the continent.

It is estimated that the annual loss from floods in the Mississippi Valley alone averages over $50,000,000.00. It does not require a very large area of land to produce that amount in wheat and there is no reason why we should not develop that land for wheat production and at the same time, by wise selection of the area to be drained, safeguard the inhabitants on the lower river. But because of the lack of co-ordination in the development of these projects in the past we have, so to speak, robbed Peter to pay Paul.

These questions cannot be settled by the United States alone. We are joined in ties of friendship and brotherhood with our neighbors on the north, Canada, and on the south, Mexico. The evidence of these ties is much stronger at present at the north than at the south, but we cannot help feeling that ultimately, conditions will become adjusted both north and south to greatly benefit the entire continent.

President Field then introduced Hon. Honore Mercier, Minister of Colonization, Mines and Fisheries of the Province of Quebec, who spoke briefly as follows:

"*Mr. President:* As I have no special subject assigned to me I will refer briefly to the fisheries with which I am best acquainted, those of the Province of Quebec. These may be divided into two classes, the inland and the coastal fisheries. The control is also divided, the Dominion framing the laws regulating closed seasons

and the methods by which fishes may be taken, while the enforcement of the laws belongs largely to the province.

At present there is a dispute between the Federal Government and the Province of Quebec as to whether or not the Dominion has absolute control of fisheries in tidal waters, but by mutual consent the interpretation of the constitution on this question has been left to the courts, with the understanding that the case will go to the highest court of the empire, the Imperial Privy Council, for a definite decision.

Our sole control of the inland waters is unquestioned. No less than ten million acres of our territory are covered with water. We have thousands of lakes, large and small, some of them hundreds of square miles in extent. Many are richly stocked with the largest and gamest specimens of brook trout and others contain lake trout or black bass. Our salmon rivers are in a class by themselves. They flow for the most part into the lower St. Lawrence and the Baie des Chaleurs. The entire St. Lawrence River, from the Ontario boundary down to the Gulf, is in the Province of Quebec and upwards of a hundred and thirty rivers, large and small, flow into it. It has been estimated that our coastal fisheries cover approximately 4,500 miles of coastline along the two shores of the St. Lawrence and the Gulf, the north shore of the Baie des Chaleurs, the eastern shore of Hudson and James Bays and the entire shore line of Ungava Bay. In the St. Lawrence River we have also the lakes St. Francis, St. Louis, Two Mountains and St. Peter.

The Federal Government operated all the fish hatcheries of Quebec Province up to two years ago, when it abandoned four of the inland ones. Our province accepted a transfer of these and assumed their cost."

Mr. E. T. D. Chambers of Quebec, in charge of the fish hatcheries of the province, Secretary of the North American Fish and Game Protective Association, and well known as an author on Canadian fishes, was introduced and responded with a brief address.

"No one could listen to the presidential address this morning without appreciating how many sided is this question of North American fisheries, their commercial value and the large contribu-

tion they make to the food supply of the world. This contribution was never more important than at the present time when the people of both our countries here are looking toward this food supply and when we wish to contribute largely to the supply of food for our Allies in Europe. From whatever angle we view the fisheries of North America we cannot fail to be interested.

We have been taught to believe that our progenitors in this country came here simply in search of liberty and that the early French explorers were actuated by the desire to start a new civilization. However, as I read history, I find that the stories of the great wealth of the fisheries brought out large numbers of the earliest pioneers and that the keen perception of the statesmen of France resulted in a great merchant marine based upon the trade in this branch of commerce.

The early French governors of Canada were led to insist upon the development of the fisheries, and to encourage them by state assistance and so very few concessions were granted. One of the concessions that were given was granted to no less a person than the great explorer Joliet.

It was only natural that rivalries should spring up between the fishermen of these new countries that led to some little misunderstandings, but I am proud to say that for more than a hundred years all such questions and disputes have been settled by treaty. May we not hope that before long the work undertaken by Professor David Starr Jordan, representing the United States, and Professor E. E. Prince, of the Dominion of Canada, will result in putting into effect the best, if not all, the recommendations they have made concerning the international fisheries of our countries."

The session adjourned for a few minutes to permit the Association of Fish and Game Commissioners to complete certain business, whereupon the Society again resumed work.

REPORT OF THE COMMITTEE ON TIME AND PLACE OF MEETING.

Mr. A. L. Millett, chairman, presented the report, stating that the committee had decided unanimously to meet at some point in the State of New York, and the date selected to be sometime in the week of September 11, 1918.

Mr. John P. Woods moved the adoption of the report, which was unanimously carried.

Mr. John W. Titcomb, Chairman of the Committee on Membership, presented the name of Hon. Honore Mercier for election as an honorary member of the Society. President Field called for a rising vote which was declared to be unanimous.

The next speaker to be introduced by the President was Hon. W. A. Killian, State Commissioner of Fisheries of Maryland. An abstract of Mr. Killian's remarks follows:

HON. W. A. KILLIAN'S ADDRESS.

"I have often wondered why the fisherman of any region have so devastated their source of livelihood, but perhaps the suggestion that it goes back to the Pilgrim Fathers and to misconceived ideas of the right of free fisheries, is correct. But it is wonderful what the conservation idea can do in a community when the logical consequences of waste and the fact that their livelihood has been destroyed is brought home to the fishermen themselves.

One of the first things recognized when the Maryland Conservation Commission was created—and I take it the same has been true in other states—is that very little can be accomplished until there is real co-operation between the states which have common interests. It was a by-word for years that no co-operation could be expected between Maryland and Virginia and one of the largest industries of these states, namely the oyster industry, had gone wrong, merely because the Potomac River forms the boundary line. The crab and fish industries also suffered greatly for the same reason. Fortunately, it was possible to arrive at an understanding. I wish to say for your encouragement that if the commissions of any two states will get together and cut red tape and form a joint partnership for handling the work they can get somewhere. That is what we have done and when we get together on the boundary line we have present all those who are charged with any part of the work. While we have had only one year of such co-operative work, enormous benefits are already apparent.

It is much easier to secure respect for law if the people appreciate the benefits to be derived. We have recently devised a plan

to reach the people directly by sending out a small leaflet to each person concerned, whose name we can secure, and we hope to at least afford them a knowledge of what legislation is proposed and when it becomes a law.

The blue crab, which is a very valuable product, was rapidly disappearing and it was difficult to secure the enforcement of legislation on account of "county exemptions" and the failure of some local justices to do their duty. But county exemptions are now prevented by law and delinquent justices were advised that unless they construed the law in accordance with its new interpretations they would be invited before a grand jury, so we have had no more trouble.

We do not hesitate to arrest a citizen of Virginia, because our laws are similar, and if the police of either state apprehend a violator, he is taken before a justice of the state in which he is a citizen. In one instance a Virginia oyster man attempted to land a considerable cargo of undersized oysters in Maryland. He was told that he could not land illegal oysters, but must cull them. This was a big job, but after he had culled them we permitted him to land the big ones. Then we took him to Virginia where he was fined a considerable sum and was made to return the small oysters to the beds. That was only necessary once last year.

Another law, recently passed, deals with the pollution of streams and tidal waters, which provides not only for a fine, but also for imprisonment for one to three years. We do not intend to be too drastic in its enforcement and we propose to send a copy of the law to every factory, large or small, asking every one to study his own problem and to eliminate harmful waste. I fully believe that if we could get the intelligent co-operation of those industries that are discharging harmful wastes into the waters, we should soon get back to the basis of greater food production."

Mr. Wm. C. Barber, of Wisconsin, in discussing the foregoing address, related a number of cases in which local justices had made improper rulings in sympathy with the offenders until warned of malfeasance. Juries also had to be warned that would be arrested for perjury unless they found in accordance with the evidence and the law.

President Field also cited a case where fishermen, who were prevented from selling polluted quahog clams in Massachusetts, petitioned to be allowed to ship them to New York. It was practically impossible for the state authorities to prevent this, but federal officers were notified and intervened. If these facts were known, that the federal authorities are now in a position to deal with interstate commerce on forbidden goods of whatever sort, a very great influence could be brought to bear to prevent such violations.

The next address, "Importance of a Permanent Policy in Stocking Inland Waters," by Mr. John W. Titcomb, State Fish Culturist of New York, has already been printed in full in the December, 1917, number of the TRANSACTIONS, Vol. XLVII, pp. 11–21.

The session adjourned.

Afternoon and Evening of Thursday, August 30th.

The afternoon of the 30th was spent on an automobile tour as the guests of the clubs of the city. This terminated in the evening at the Automobile Club where dinner was served. At the close of the dinner the Society convened for an evening session.

Mr. Harold Harris, on behalf of the various clubs, acting as host of the occasion, made a brief address of welcome and called upon the following members, each of whom responded briefly:

Mr. Honore Mercier, Minister of Colonization, Mines and Fisheries of Quebec.

Mr. James White, Deputy Head of the Conservation Commission of Canada.

Mr. M. L. Alexander, President of the National Association of Fish and Game Commissioners and Conservation Commissioner of Louisiana.

Dr. Geo. W. Field, President of the American Fisheries Society.

Mr. Henry O'Malley, of the U. S. Bureau of Fisheries, Vice-President of the American Fisheries Society.

Prof. Henry B. Ward, of the University of Illinois.

Mr. John W. Titcomb, State Fish Culturist of New York.

Judge J. H. Kirk, State Fish and Game Commissioner of North Dakota.

Mr. F. Brash, Chief Game Warden, Saskatchewan, Canada.

Mr. G. A. Smith, State Fish Commissioner, of Oklahoma.

Mr. Geo. H. Graham, Fish and Game Commissioner of Massachusetts.

Mr. John M. Crampton, Superintendent of Fish and Game of Connecticut.

Mr. Carlos Avery, Fish and Game Commissioner of Minnesota and Secretary of the American Fisheries Society.

Adjournment.

Friday Morning Session, August 31st.

President Field called the meeting to order and asked for the reports from the committees.

REPORT OF THE NOMINATING COMMITTEE.

Mr. John P. Woods presented the report, in which the following were suggested for Officers of the Society for the year 1917–18:

President.....Mr. Henry O'Malley
Vice-President.....Mr. M. L. Alexander
Recording Secretary.....Mr. John W. Titcomb
Treasurer.....Mr. A. L. Millett
Editor.....Prof. Raymond C. Osburn

Vice-Presidents of Divisions

Fish Culture.....Dwight Lydell, Comstock Park, Mich.
Aquatic Biology and Physics...Henry B. Ward, Urbana, Ill.
Commercial Fishing.....J. F. Moser, Alameda, Cal.
Angling.....Daniel B. Fearing, Newport, R. I.
Protection and Legislation, Geo. A. Lawyer, Washington, D. C.

Executive Committee.

Carlos Avery, *Chairman*.....St. Paul, Minn.
John P. Woods.....St. Louis, Mo.
John S. Parsons.....Accomac, Va.
C. O. Hayford.....Hackettstown, N. J.
J. Q. Ward.....Frankfort, Ky.
W. H. Killian.....Baltimore, Md.
Carl Westerfeld.....San Francisco, Cal.

Committee on Foreign Relations.

George Shiras, 3d, *Chairman*.....Washington, D. C.
Hugh M. Smith.....Washington, D. C.
W. W. Barber.....Madison, Wis.
James White.....Ottawa, Canada.
Chas. H. Wilson.....Glen Falls, N. Y.

Committee on Relations with National and State Governments.

Jacob Reighard, *Chairman*.....Ann Arbor, Mich.
Wm. L. Finley.....Portland, Ore.
Wm. C. Adams.....Boston, Mass.
E. W. Nelson.....Washington, D. C.
E. T. D. Chambers.....Quebec, Canada

Publication Committee.

Raymond C. Osburn, *Chairman*.....Columbus, Ohio
Bashford Dean.....New York, N. Y.
John T. Nichols.....New York, N. Y.

It was moved and carried that the Secretary cast one ballot for the officers named.

COMMITTEE ON FOREIGN RELATIONS.

No formal report was presented, but Hon. George Shiras 3rd, Chairman, outlined some of the problems which had come before the committee for discussion. One of these was the question of Federal control of migratory fishes on a similar basis to the migratory bird law. Also the question of government control of tidal, interstate and international waters, and the proposition to extend the three mile limit to twenty miles with control of the fisheries

over that area. Some of the difficulties and possibilities of legislation along these lines were suggested in order to acquaint the Society with the work with which the committee is engaged and on which it intends to report later.

COMMITTEE ON AMALGAMATION OF THE AMERICAN FISHERIES SOCIETY AND THE PACIFIC COAST FISHERIES SOCIETY.

Mr. Henry O'Malley, Chairman, reminded the Society that his committee was appointed at the San Francisco meeting in 1915 to consider the amalgamation of these societies and that the By-laws of the American Fisheries Society were changed at the time to provide for branches. He reported that the Chairman of the Executive Committee of the Pacific Coast Fisheries Society informed him that at their meeting, held in July, 1917, it was unanimously voted to join hands with the American Fisheries Society. He further stated that all that remains to be done is to get in touch with the proper officers of the Pacific Coast Society and the amalgamation may be properly concluded at the next annual meeting, and suggested that a committee be appointed to take charge of the matter.

Mr. John P. Woods moved that the present committee be continued to complete the arrangements and the motion was unanimously carried.

REPORT OF THE AUDITING COMMITTEE.

Mr. Geo. H. Graham, Chairman, reported that the Auditing Committee had examined the Treasurer's account and found it to be correct and accompanied by the proper vouchers.

A motion that the report be adopted was put and carried.

Discussion of Mr. Titcomb's Paper.

The address presented by Mr. John W. Titcomb on the previous day was then taken up for discussion. (See TRANSACTIONS, December, 1917, pp. 11–21, where this paper appears in full), and Mr. Titcomb first gave a resume of the paper.

Mr. Wm. E. Barber, of Wisconsin, stated that as an emergency measure the Wisconsin Commission in 1917 was ordered to oversee the distribution of rough fish within the state boundaries.

These were marketed at five cents a pound. Carp were distributed in eight different places and in Milwaukee 36,000 pounds a month were taken. He stated also that the Wisconsin fish and game laws had been codified, resulting in more uniformity.

Mr. John M. Crampton, of Connecticut, called attention to the pollution of waters and cited a number of very flagrant cases of pollution resulting in the death of fish in the State of Connecticut.

President Field stated that the ordinary game laws lack elasticity in meeting the situation. With the improved presonnel in the boards of commissioners, they should be given greater responsibility and allowed to make regulations to meet existing conditions as they rapidly change, since it often happens that before a law can be passed and enforced the condition has passed beyond all remedy.

Mr. Geo. H. Graham, of Massachusetts, deplored the fact that changing political conditions bring about changes in the state commissions and make for changes in policy. If there is any possible way by which a permanent policy can be arranged for, it should be established. The indiscriminate stocking of waters is a great evil, because once obnoxious species are established, it is impossible to get rid of them. Mr. Graham mentioned numerous cases in New England where improper stocking had resulted in the production of undesirable fishes to the detriment of more desirable species.

Mr. Titcomb, continuing the discussion, stated that there are many lakes in which the trout fishing has been spoiled by the introduction of other fishes such as the bass, pickerel and carp. Where pickerel have come to stay, trout planting may as well be stopped and other food fishes like the perch introduced, which will feed the pickerel and also afford food for those who are not expert anglers. Where black bass have been introduced into New York and New England waters there is a general closed season on them covering the breeding period, though the bass do not thrive very well in these trout waters.

Mr. Titcomb recommended that the closed season be removed from the bass, thus reducing their numbers and also offered the suggestion that the bass nests be screened so that after hatching,

the young may be removed to other places where it is desired to propagate the bass. In a similar manner the perch eggs may be collected and all these measures tend to give the trout a better chance. The carp has been introduced into many New York waters that are not particularly suited to them, but the general fisheries laws protect them during the breeding season. If provision was made to permit taking them during the breeding season they would be valuable for food and at the same time their numbers would be reduced in favor of more desirable fishes which are better suited to these waters.

Fish Waste, Past and Present.

BY DR. S. P. BARTLETT,
U. S. Bureau of Fisheries, Quincy, Ill.

(For this paper, see TRANSACTIONS, Vol. XLVII, No. 1, Dec., 1917, pp. 22–27)

Professor Henry B. Ward, in discussion, called attention to the fact that the public are often misled into the belief that carp, bowfin and other cheaper fish are worthless as food, or are even dangerous, while as a matter of fact the choice between salmon or whitefish and carp has no bearing on the question of nutrition. One is as wholesome and nutritious as the other, yet many people have been prejudiced to the extent that, when they cannot afford to buy the higher priced fishes, they refuse to take any. Professor Ward praised the merits of smoked carp and bowfin and cited a demonstration by an expert in home economics which proved to a group of previously prejudiced women that these fishes when smoked are preferable to finnan haddie. Experts in fisheries matters especially should be careful, praticularly in these days of high prices, that the public is made to understand that these cheaper fishes are as nutritious as any others and that they can be prepared in ways to make them highly desirable.

Mr. Carlos Avery, of Minnesota, mentioned the need in his state of a campaign of education on the edible qualities of the carp, especially in the fresh condition. Millions of pounds of carp are being shipped outside the state, but they are not being utilized at home as they should be.

Mr. John P. Woods, of Missouri, stated that the U. S. Bureau of Fisheries is glad to furnish recipes for cooking the various kinds

of fish. He mentioned the fact that he had served carp as "silver salmon" to a party of friends, all of whom thought it as good fish as they had ever eaten. The whole difficulty lies in prejudice.

Mr. John W. Titcomb, of New York, cited a similar illustration. At a meeting of the sportsmen and anglers of Vermont, at which a number of distinguished fisheries experts were present, carp was served under the disguise of "red snappers." The carp, with a recipe for cooking them, had been sent from Illinois by Dr. Bartlett. Some of the guests thought they were whitefish, others that they were pike-perch, but no one knew what he was eating and all enjoyed and praised the fish. He spoke also of serving smoked carp at a meeting of the conservation commission and all agreed that they preferred it to smoked halibut. He admitted that he had referred to carp in certain New York waters as "vermin," but did not wish to be misunderstood. There is a great demand for carp in New York City and many New York lakes are filled with these fish, but there is no provision for taking them except by angling and it would be better if several hundred thousand pounds could be removed annually and utilized.

Mr. Wm. E. Barber, of Wisconsin, explained how the state handled carp during the summer of 1917. The Council of Defense issued bulletins and distributed them generally to the mayors of cities and newspapers. Then 2,000 lbs. of carp were shipped to Milwaukee and sold out in less than an hour. Then 3,000 lbs. were disposed of in a half hour, then 5,000 lbs., after which they took all they could get. At Madison, Oshkosh and elsewhere, they soon became popular. Now the fishermen are allowed four cents a pound for the fish, the state adds another cent for expenses and the city another cent. This allows them to be sold at six cents a pound and it is believed that the state will take its whole output. The carp, living in muddy water, naturally have a muddy taste, but if they are cleaned and the skin removed, and are then soaked in salt water over night they will be as good fish as anyone could wish.

Professor Ward also insisted upon the advisability of skinning the carp before cooking and recalled his experience in Germany, where the carp command a higher price than trout because they are marketed alive and in this condition can regularly be bled when killed for cooking.

Mr. John L. Curran, of Rhode Island, called attention to the fact that carp are sold in Providence only in the Jewish markets. He stated further that shark meat has advanced in price on eastern markets, but both sharks and skates should be utilized to a much greater extent. The squid is scarcely utilized at all. The flounder and fluke are scarcely known on the markets except on the coast, though we all know their delicate qualities when, under the magic of the cook, they become "filet of sole."

Mr. Henry O'Malley, of the U. S. Bureau of Fisheries, stated that the Bureau is preparing a pamphlet on the carp, giving recipes for cooking and instructions for ridding it of any muddy flavor. He stated that over 500,000 lbs. of smoked carp, requiring 1,500,000 lbs. of fresh carp for the preparation, were marketed in New York City last year. The carp market of New York is one of the big fish centers of that city.

Discussion of Stream Pollution.

A paper on stream pollution by Mr. G. A. Smith, Commissioner of Fisheries of Oklahoma was called for, but owing to the absence of the author was not read. President Field suggested that the question should be discussed as a matter of record.

Mr. Geo. Shiras, 3d, of Washington, D. C., stated that the best way to secure action in cases of stream pollution is by interesting local health departments, after a careful study of conditions involving the economic side of the question. Many streams are little better than open sewers and the health authorities are the proper means for remedying this condition. Individuals owning land along a stream can sue anyone polluting the stream for the abatement of the nuisance. The state may take the lead in pollution cases, but in the case of very important mills or other plants, it is difficult to obtain action. But what is especially needed is general congressional action regarding interstate waters, for it is especially the larger streams in which it is most difficult to prevent pollution and many of these are interstate waters. The Supreme Court of the United States has already laid down the general principle that no state has reason to pollute the waters of another state. At present, however, the only redress is for the one state to bring continued legal action against the other, and what is

needed is congressional authority for an interstate waterways commission of scientific men capable of passing on the question of pollution.

The Difference Between Steel-head and Rainbow Trouts.

By Mr. W. M. Keil, of Tuxedo Park, N. Y.

In the absence of Mr. Keil his paper was read by title, but a series of drawings and X-ray photographs was shown.

The following papers were also read by title:

Trout Fishing near Winona and Manner of Stocking Streams.

By Mr. Earl Simpson, Winona, Minn.

Fisheries in the Mississippi Valley.

By Mr. D. C. Booth, of Homer, Minn.

Fisheries of the Upper Mississippi.

By Mr. M. N. Lipinski, of Winona, Minn.

Mr. Austin F. Shira, Director of the Fairport Biological Station of the U. S. Bureau of Fisheries, was then called upon for his paper on *Fish Cultural Activities of the Fairport Biological Station.* (This appears in the TRANSACTIONS for December, 1917, Vol. XLVII, No. 1, pp. 39–44.)

The morning session was then adjourned.

Friday Afternoon Session, August 31st.

Mr. Geo. A. Lawyer, of Washington, D. C., moved that the chair appoint a committee to formulate a statement of the essential principles relative to the conservation of fisheries resources. The motion was seconded and carried.

Experiments on the Re-stocking of Devils Lake, N. Dak.

By Mr. Alfred Eastgate, St. John, N. Dak.

On Sending Fishing Tackle to Our Brother Sportsman With the Allied Armies. By Mr. J. W. Johnston, Rochester, N. Y.

One of the problems which confronts those interested in the welfare of the soldiers of the Allied Armies is that of providing healthful recreation during their spare time. About the middle of June an article by Miss Clara Norton appeared in the *New York Times* suggesting that fishing tackle be supplied, and the British sportsmen, through the *Fly Fisher's Gazette*, have fathered such a movement in Great Britain. The tackle, consisting of rod, reel, line, hooks, etc., has been put up in packages and forwarded, usually through the Young Men's Christian Association. There are many sportsmen in the army and, if they can be provided with the means of spending an idle hour pleasantly, the influence will be very great, for the problem of recreation is a very important one.

If this movement is supported by such a body as the American Fisheries Society that fact will have its influence. (Abstracted.)

President Field: No doubt there are many of the members of this Society who will be glad to contribute tackle, or money to provide for it, and I see no reason why the Society as a whole should not indorse the movement.

Mr. John P. Woods: I think we should support this measure, for while we may be scientists, naturalists and so forth, we also have good sporting blood in us.

President Field: I think that voices the sentiment of the whole Society.

The Mussel Beds and Fisheries of Louisiana

By Mr. E. A. Tulian, of New Orleans, La. Read by title.

The Eggs of Buffalo-fish.

By Mr. H. L. Canfield, Superintendent of Fish Culture, U. S. Biological Station, Fairport, Iowa.

Fish Farming.

By Mr. John P. Woods, Missouri State Fish Commissioner, St. Louis, Mo. Read by title.

Increasing the Output.

By Mr. W. O. Buck, U. S. Bureau of Fisheries, Neosho, Mo. Read by title.

REPORT OF COMMITTEE ON RESOLUTIONS.

Presented by Prof. Henry B. Ward.

I. *Resolved:* That the American Fisheries Society hereby expresses its thanks to the members of the Local Committee and the Clubs of St. Paul for the entertainment which has been provided during the meeting and which has made our visit one to be remembered.

II. *Resolved:* That the State Fisheries Authorities of Minnesota be assured of our obligation to them for their interest in this meeting of our Society; and

III. *Resolved:* That our special thanks are due to Commissioner Carlos Avery, who, as Secretary of this Society, has been largely responsible for the great success of this meeting.

These resolutions were adopted by vote of the Society.

Protection and Destruction of Food Fishes in the Great Lakes. By Mr. S. W. Downing, U. S. Bureau of Fisheries, Put-in-Bay, Ohio.

This paper appears in full in the TRANSACTIONS for December, 1917, Vol. XLVII, No. 1, pp. 28–35.

A Hatchery Maintained by a Fish and Game Protective Association. By Mr. C. H. Bower, of Columbus, Ohio. Read by title.

The Establishment of Fisheries Schools. By Dr. O. T. Olsen, Grimsby, England. Read by title.

The General Routine of a Trout Hatchery. By Mr. R. L. Ripley, Bayfield Fish Hatchery, Bayfield, Wis.

No discussion.

Additional Notes on Rearing the Channel Catfish (Ictalurus punctatus). By Mr. Austin F. Shira, Director, Fairport Biological Station, Fairport, Iowa.

This paper appears in full in the December, 1917, number of the TRANSACTIONS, Vol. XLVII, No. 1, pp. 45–47.

Improve the Canned Fish Product. By Mr. K. Hoyden, Monterey, California. Read by title.

Mixing Trout in Western Waters. By Aldo Leopold, U. S. Forest Service, Albuquerque, New Mexico. Read by title.

Secretary Avery read letters from Dr. Chas. H. Townsend, Director of the New York Aquarium, from Dr. Raymond C. Osburn, the Editor of the Society and from Mr. N. R. Buller, Commissioner of Fisheries for Pennsylvania.

President Field: My last duty, before this annual meeting is brought to a close, is the appointment of the committee provided for by your action, as the result largely of the suggestions made in Mr. Titcomb's paper. This Society needs a creed and its creed should be in such form that it can be applied to specific cases both in Federal and State legislation. The committee to be named is to formulate a statement of the fundamental principles essential to legislative practice relative to the proper utilization of the fisheries resources of the United States. I will ask Mr. John W. Titcomb, of New York, to act as chairman, with Mr. Chas. O. Hayford, of New Jersey, and Dr. Chas. H. Townsend, Director of the New York Aquarium, and the incoming President, Mr. Henry O'Malley, of the United States Bureau of Fisheries, as a member *ex officio.*

Editor's Note.—The committee above named has drafted the following set of resolutions, which, although the Society has had no opportunity for formally approving them, are of such importance that they should be made public as soon as possible.

REPORT OF COMMITTEE ON PRINCIPLES OF LEGISLATION RELATIVE TO PROPER UTILIZATION OF FISHERIES RESOURCES.

Whereas, Under the stress of present conditions the nation has been brought to look carefully into the character and the amount of its various food supplies; and,

Whereas, In the past it has, through lack of attention, failed to appreciate in any real sense the significance of its food fishes and the opportunities afforded by its numerous and varied water bodies to produce a large and important element for the food supply of the nation and,

Whereas, We, members of the American Fisheries Society, in session at the Forty-seventh Annual Meeting held at St. Paul, Minnesota, by virtue of our contact with the fishing industry and

knowledge of its problems and opportunities, being thus aware of the dangers in the situation and cognizant of the various lines in which the nation can be benefited at the present time, desire to record in formal manner those fundamental principles which appear to be essential to wise legislation and to effective work for the proper utilization of the fishing resources of the nation, and do accordingly express these views; and,

WHEREAS, Under the stress of war conditions expert advice and trained supervision is even more necessary than in ordinary times; and,

WHEREAS, Hasty or inexperienced action may easily result in the depletion of natural resources which cannot be restored within a long period of years; and,

WHEREAS, In the staff of the United States Bureau of Fisheries, and in the trained experts of the State Bureaus, Commissions, and Hatcheries, the country is possessed of a body of highly trained men devoted to the needs of the nation as a whole and qualified to speak on special problems of fisheries in the war with the knowledge and experience that will guard against the evident danger of hasty action; and,

WHEREAS, proposals have been made to suspend or revoke laws for the regulation of fisheries which have grown out of long experience and careful study of conditions regarding the habits, growth, and multiplication of fish on the one hand, and the practical conditions of the fishing industries on the other hand; and,

WHEREAS, The shad, striped bass, and other anadromous species have decreased in some rivers almost to the point of extinction, because of fishing devices operated in the salt and brackish waters through which they must pass to reach their natural spawning grounds in fresh water; and,

WHEREAS, Artificial propagation of these species is impossible and natural reproduction is prevented unless a reasonable supply of such fishes is allowed to reach their natural spawning grounds in fresh waters; therefore,

Be It Resolved, That the expression "letting down the bars" as applied to the fishery resources of the country is unfortunate; national welfare demands the greatest development of the said fisheries, including fish culture and the artificial propagation of food fishes to the highest possible point of efficiency;

Resolved, That commercialization of the so-called game fishes is not conducive to their proper conservation but would tend to destroy a limited but valuable food product—the annual catch under present restrictive laws, aided by artificial propagation, being barely sufficient to maintain a reasonable annual supply;

Resolved, That the taking of non-game food fishes, under proper supervision, be encouraged in every legitimate manner consistent with the preservation of a sufficient breeding stock to insure a future normal crop, (in states where required, necessary legislation to this end should be enacted);

That many waters in which the so-called game fishes predominate contain also rough fish such as carp, suckers, bowfin, gars, etc., and in such waters the removal of these non-game fishes will be beneficial to angling, and a limited amount of commercial fishing, under proper regulation, should be encouraged;

Resolved, That the anadromous fishes should be permitted to ascend the rivers from the ocean in sufficient numbers to maintain a constant and normal supply, and that to this extent the commercial fishing should be subject to proper regulation; and,

Be It Resolved, That a solution of this problem relating to the alarming decrease of these species rests in the Federal control of all anadromous fishes; and,

Be It Further Resolved, That a copy of these resolutions be forwarded to the Bureau of Fisheries, the United States Food Administration, and the fisheries authorities of the various states.

(Signed) JOHN W. TITCOMB, *Chairman.*

President Field then introduced the incoming President, Mr. O'Malley, who spoke very briefly.

On motion by Mr. John P. Woods, the Society expressed its appreciation of the work of President Field by rising, after which it formally adjourned.

EDITORIAL.

The Next Annual Meeting. The Forty-eighth Annual Meeting of the American Fisheries Society will be held in the State of New York on September 9, 10 and 11, 1918. The exact place of meeting has not yet been determined but will be announced later. There has been considerable discussion in the various scientific societies as to the propriety of holding meetings under present conditions of travel and railway congestion. While it may be advisable for certain societies to forego their meetings, it seems to the writer that there never has been a time in the history of this Society when a full attendance at the regular meeting was more desirable. A very large percentage of our membership consists of men who are interested in the practical and economic phases of fisheries work; and conservation, greater utilization of fish, especially the cheaper kinds, the increased use of by-products, greater production, improved methods of marketing, etc., are matters which concern the welfare of the whole nation, now and in the future. Keep the date of the meeting in mind and be fully prepared for the discussion of these and other important problems of wide application.

* * *

Fresh-water Biology. By Ward and Whipple.—A Review.

The members of the American Fisheries Society will all be interested to learn that a most important publication bearing the above title has just made its appearance from the press of John Wiley and Sons, New York. The responsible authors, Dr. Henry Baldwin Ward, Professor of Zoology in the University of Illinois and Dr. Geo. Henry Whipple, Professor of Sanitary Engineering in Harvard University and Massachusetts Institute of Technology, have been aided by a staff of twenty-five specialists in the various groups of fresh water organisms. The amount of material embraced in the volume of over eleven hundred pages is stupendous, and only the enlistment of a large corps of able specialists could ensure such satisfactory and authoritative results.

The work has been under way for many years and it seemed to some of us as though it never would make its appearance, but the long awaited results are not in the least disappointing. To be sure, one may pick flaws here and there, but where lives the scientist who was ever quite satisfied with another's work?

Following the introduction by Ward, are excellent chapters dealing with the conditions of existence in fresh water, by V. E. Shelford, and methods of collecting and photographing, by Jacob Reighard. The Bacteria are treated by E. O. Jordan, the Algæ by E. W. Olive and Julia W. Snow, and the larger aquatic plants by Raymond H. Pond. The treatment of the various zoological groups from the Protozoa to the aquatic vertebrates—the work of numerous specialists—occupies more than three-fourths of the book. A chapter on sanitary and technical problems, by Whipple, closes the volume.

From the standpoint of one interested in fish culture it seems regretable that a key to the commoner forms of the higher plants that are fully aquatic, such for instance as the pond weeds, was not included, but there are numerous good works on systematic botany which may readily be obtained. One misses also any reference to the Sporozoa, the Protozoan forms so commonly parasitic on fishes, but this was probably conditioned by the inability to find any specialist to undertake this little-known group. No synoptic treatment of the fresh-water vertebrates is attempted, owing to limitations of space; but systematic works on the fishes, amphibia and reptiles are easily available in other literature, and Prof. Eigenmann's general discussion is interesting and valuable.

The chapters dealing with the animal groups most closely related to the economy of fishes, either as parasites, or as food, are all well done. For the first time in the history of American zoology do we find a comprehensive discussion of the parasitic flat worms and round worms. The biological interest in these groups is necessarily very great and their economic importance can scarcely be overestimated; but, owing to the scattered nature of the literature, it has been exceedingly difficult to do satisfactory work on them. Professor Ward's complete and authoritative treatment of these groups is therefore of special

value. The leeches are discussed in a very satisfactory manner by Dr. J. Percy Moore. The very full treatment of the wheel animalcules or rotifers, by Prof. H. S. Jennings, is a delight to the zoologist. The numerous smaller Crustacea, so important as fish food and in some cases as parasites, are handled by well known specialists, A. S. Pearse (Phyllopoda), E. A. Birge (Cladocera), C. Dwight Marsh (Copepoda), and R. W. Sharpe (Ostracoda). Of the chapter on the higher crustaceans it is sufficient to say that it is the work of Dr. E. A. Ortmann. The aquatic insects and mollusca are so numerous that a volume would be required for the full discussion of either group, yet Prof. Jas. G. Needham has accomplished a great deal in the seventy pages alloted to the former group, and Dr. Bryant Walker has also done much with the mollusca, considering the limited space.

It must be borne in mind that this is not merely a systematic work, but that much space is devoted to ecological and economic aspects of the various forms, to life histories and other general biological considerations.

The whole volume is profusely illustrated, and all the cuts are new and drawn from specimens. Keys are provided in all groups except the higher plants and the vertebrates, and the most important reference works on each group are cited in a literature list at the end of each chapter. The index is very complete.

As stated in the author's preface this is the first attempt "to deal with North American fresh-water life in its entirety." While such a work is necessarily incomplete, even in a large volume, there is great value in the accumulation of such a mass of material from scattered sources, as it is thus rendered available for the general worker as well as for the specialist. Fisheries men and other individual workers interested in the life of the fresh waters of North America will all welcome this volume, and for the colleges and aquatic laboratories it will be a necessity.

R. C. Osburn.

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"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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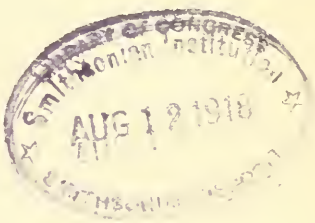

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METHODS OF COLLECTING AND HATCHING BUFFALO-FISH EGGS AT THE U. S. FISHERIES BIOLOGICAL STATION, FAIRPORT, IOWA.

By H. L. Canfield,
Superintendent of Fish-culture.

The rapidly decreasing supply of the food fishes of the Mississippi River and tributary streams, makes imperative the need for additional knowledge regarding their habits. More applicable measures for their protection may then be instituted and the natural increase may be supplemented, as far as possible, by artificial means. Prior to the time the work was taken up in an experimental way at the Fairport Station, absolute failure or, at most, very little success had resulted from the efforts of fish culturists to collect and hatch the eggs of the buffalo-fishes of the genus *Ictiobus*. A brief statement, then, of the methods we have employed and the results obtained, will be of interest and value.

The spawning of the buffalo-fishes, of which there are three recognized species in our vicinity, takes place ordinarily between April 15th and May 15th, in that section of the Mississippi River between Davenport and Keokuk, Iowa, at which time the annual spring rise of the river occurs. During this rise the lowlands, which in times of ordinary water stages are dry, become inundated and furnish very favorable spawning grounds for the buffalo. Knowing the movements of the fish and realizing the impossibility of taking many of them with seines, the commercial fishermen catch them chiefly with fyke-nets provided with wings and with funnel hoop-nets. The fyke-nets are set mainly on inundated lands in the woods adjacent to rivers and inland sloughs, where there is a current of water, while the hoop-nets are used along the shores and entrances to inland sloughs. The larger part of the eggs hatched at Fairport during the past three seasons was secured from fish taken and marketed by the commercial fishermen, thus representing a supply which would otherwise have been a total loss. It has been noted that, as the water recedes the catch of buffalo greatly diminishes. From the fact that many of these, taken at this time, are still unripe, it is presumed that such unripe fish naturally

return to the river, perhaps to seek more favorable spawning grounds. It is necessary, therefore, to prosecute the work vigorously during the rising stage of the river.

The larger fish markets furnish table space and equipment to the fishermen for dressing and weighing their fish and purchase them when ready for the market. In localities where this method of sale prevails the fisherman visits his nets, raises and empties them, and on completion of the rounds proceeds to the fish market. Although this method of handling the fish is quite rough, the fish arrive at the market alive, even though they have been removed from the water from one to four hours, the weather being quite cool at this season of the year. Promptly on arrival, our spawntakers go over the catches, stripping and fertilizing all ripe eggs. This arrangement makes the collection of the eggs quite economical, with minimum annoyance to the fishermen. A gentler way would be to have the spawntakers accompany the fishermen and take the eggs as the fish are removed from the nets, but this would require the services of a prohibitive number of spawntakers. Furthermore, so far as we have been able to determine, no definite injury is done the eggs by handling the fish in this manner. The hatch appears to be quite as good and the fry as strong as when the eggs are obtained from fish immediately after their removal from the water. In localities where fish are prepared for market in the field, it is necessary to collect the eggs at scattering fishermen's headquarters. This is done by accompanying the fishermen to the nets or by instructing them how to take and care for the eggs until they can be gathered up by a member of the Station force.

The work done at the Station in the propagation of the buffalofish has been much appreciated by the active fishermen and market men of the region. They have co-operated fully in facilitating the egg-collecting and have assisted in every way possible, giving freely of their time and labor for the good of the work.

In spawning the fish, the pan is rinsed with water and drained, but not dried. The female fish is held in the usual manner over the pan and the eggs are ejected into it by gentle pressure over the ovaries and toward the vent. The milt from the male fish is then stripped into the pan by a similar process. The contents of the pan are gently and thoroughly stirred with the fingers at intervals

for about five minutes, to insure impregnation. Two tablespoonfuls of ordinary corn starch are now added and thoroughly stirred in for about ten minutes to keep the eggs separated. After this the eggs are washed by gently pouring water into and then out of the pan, repeating the process until the eggs are quite clean, gently stirring them meanwhile to keep the eggs separated. During washing, the eggs become water hardened.

If a hatching battery is near at hand, the eggs may now be transported to it in a pail or other receptacle. If shipment is necessary the eggs are poured on canton flannel trays and the trays stacked and placed in the ordinary field shipping box, with the upper tray serving as an ice hopper and the lower one as a cushion for the balance of the stack. On arrival at the station the eggs are tempered carefully and the trays are then moistened by floating them in tanks. As the eggs have become cemented together and to the trays, in transit, they must be gently scraped off in enmassed strips, by means of a dull hand scraper and placed in a tub of fresh water. They are then washed and brushed through a one-eighth inch mesh bobbinet-bottomed tray into a tub of clean water. In this process the tray is held so that the eggs are slightly immersed in the water. By sifting and by raising and lowering the tray and gently brushing the eggs through the meshes with the fingers, or with an ordinary paint brush, the process is made more easy for the operator and safe to the eggs.

After this process the eggs are again washed by changes of water as previously described, then poured into the Downing jars, placed on the battery shelves and running water admitted. The following day it is necessary to again pass the eggs through the bobbinet tray to separate them, but under ordinary conditions no further trouble of this nature occurs. In the event of the eggs becoming enmassed by fungus, they should be washed and separated and the good eggs given a dip or quick bath in a weak salt solution, sufficiently strong to remove the fungus.

It should be emphasized that roily water is not troublesome and as the ordinary river water is of the proper temperature, it is preferable to clear water of lower temperature obtained from springs or otherwise. Temperatures fluctuating between 52 and 62 degrees Fahr. have given no trouble but a range of 56 to 62

degrees is still better. If the best results are to be obtained unfavorable temperatures should, of course, be avoided.

The eggs measure 180,000 to the fluid quart, are of a light amber color and very glutinous. They "eye" in three to four days at an average temperature of 62 degrees and hatch in nine or ten days. The fry are approximately three-sixteenths of an inch long when hatched, and the yolk sac is completely absorbed in about three days. The fry swim up nicely and are not cannibalistic.

A very fine meshed screen must be used in screening the fry retaining-tank, in order to prevent the escape of the young fish.

PLANTING FISH IN AN ALKALI LAKE.

By Alfred Eastgate,
St. John, N. D.

The line of work on which I shall report was begun five years ago by the Biological Station of North Dakota in the effort to find the proper means of restocking the lakes of this state. In former years these lakes were full of fish of various kinds, weighing up to thirty-five pounds.

In the latter eighties there was a very dry year and the water was greatly lowered, resulting, of course, in greater concentration of the salts. At the same time the fishermen continued their operations on the restricted water area and eventually the entire fish supply of Devils Lake was exterminated. This lake, which comprises about forty-five thousand acres at the present time, for several years furnished fish dealers contracts calling for three to seven carloads of fish a week. In 1886 I saw a great haul made with a net so large that four horses on each side were required to land the catch. The fish were shoveled into great tanks and shipped in refrigerator cars. That is the way in which the supply was exhausted.

After a few years the cry went up that fish could no longer live in Devils Lake on account of the salt water. The water, of course, is what we commonly call alkali and it contains about thirteen per cent of solids, with a mixture of several salts.

Prof. M. A. Brannon, of the State University, took up the work of finding out why the fish did not live in Devils Lake. He went at it systematically and studied the water and all its contents, with the plant and animal life, but could find no reason. About ninety-seven per cent of the fish introduced from fresh water died immediately.

Dr. Brannon worked on this problem about five years before I was called into the service. My work was simply to do what he laid out for me, to carry on the practical work in accordance with his suggestions. The state fish commissioner at that time did not think much of scientific work along fisheries lines and would not

co-operate in any way, except to grudgingly supply a few fish and spawn. The first bunch of fish we hatched were steel-head trout. As we had no facilities at the Laboratory, I hatched them at the State University at Grand Forks and transported them to the lake when they were ready to plant. We also had some wall-eyed pike. The work that summer was rather discouraging.

The next summer things were in better shape at the laboratory, and it was then that Dr. Brannon made a discovery which has proved to be the solution of our difficulty. He was working on the plants of the lake and found that those living in the alkali water showed a pressure five times as great as those living in fresh water. Immediately we planned out a new line of work, applying the same principle made use of to accommodate a man to work under high air pressure, that is, the man goes from one chamber to another with increasing pressure until finally he is able to work in a pressure that would kill him in five minutes if he went there directly. When he is done with his shift he goes back gradually and is none the worse for it.

We constructed a series of cement tanks for experimentation and in six weeks had worked out the problem with great success. The fish are put into fresh water for a day and then twenty per cent of the alkali water is added. The next day the percentage of alkali water is raised to forty and the next day to eighty. Then they go into the full strength alkali water for a day, after which they are ready to go into the Lake, with a loss of only about one-tenth of one per cent. We have tried black bass, steel-head and rainbow trout, wall-eyed pike, bull-head and pickerel (though the pickerel are not to be introduced into the lake). We hope to have the plant enlarged, as the one in use was built merely for experimental purposes.

We have also tried the experiment of hatching eggs in the alkali water. We received the eggs from Put-in-Bay, Ohio, and so put them all in fresh water, except one jar which was supplied with the lake water. The fish hatched in the alkali water are better and stronger and in the five years that we have used the pure lake water we have failed to find the least trace of fungus. You all know how interesting it is to work with fungused wall-eyed pike eggs, but we have seen no trace in the alkali water.

A week ago I seined in Devils Lake, because it was said that there were no longer any fish there. In spite of the difficulties of seining in water filled with heavy vegetation I drew out three large fish. It is merely a matter of business to restock the Lake. If the people can be interested enough so that they will plant the lake by millions instead of a few thousands it will be only a matter of a little time till the lake will be as full of fish as it ever was. The natural food supply is abundant.

The density of Devils Lake varies greatly from April to the last of August, at which time it reaches about its lowest stage.

Those of you from the east do not have to deal with alkali waters, but to those of you who do I would say, by all means get in touch with your universities and have them make a complete investigation.

THE LAKE SUPERIOR HERRING.

By A. C. Dunn,
Duluth, Minn.

It is not the intention of this paper to discourse learnedly on the inner secrets of the life history of our fish or other members of the wild life coming under the observation of those generally interested in game and fish from a sportsman's standpoint. The writer has probably fished and hunted more than the average citizen, as is the usual case of those brought up in the more primitive environs of Northern Minnesota. However, for the past three years it has been necessary for me to confine my attention to commercial fisheries and make a study of them, in order to convert the natural resources of Lake Superior into the more usable dollars.

To the majority of those here assembled Duluth is not considered a fishing port, and of those who are aware that more or less fish are shipped from Duluth, only a very few know to what magnitude the fishing industry has grown. Indeed, our own neighbors at home would scarcely believe that there are more than a dozen companies competing tooth and nail for a share of the business. So keen has this competition become that an altogether unique sales condition has grown up among us, peculiar only to Duluth.

Lake Superior does not produce many commercial varieties. Indeed, outside of the herring and trout, there are only a few fish of any importance. The sale of Menominees, Bluefins, Ciscoes and Whitefish, is only a very minor and insignificant item as compared with that of the Lake Superior Herring.

Last year, in order to improve conditions in the fisheries of Lake Superior, so far as Minnesota was concerned, we were very ably assisted by the Game and Fish Commission, and especially by our local game warden, John Green, and through his efforts very authentic statistics bearing on the question were secured. It was shown that there were then 350 fishermen engaged in the industry, at least 320 of whom were independent operators, living on their own or leased property, making the business of fishing practically their only means of livelihood. Their combined outfits, including nets, skiffs, etc., was estimated at upwards of $65,000.00.

As we have said, there are a dozen firms engaged in the gathering and disposal of their output. There are five good sized steamers and seven or more gasoline freighters in the service of these companies, the combined value of which would probably reach $150,000.00, employing, during the busy season, 88 men on a payroll running to $6,340.00 per month.

The property of those companies which are fortunate enough to own dock frontage is estimated at $175,000. Others rent or pay storage to the extent of about $9,000.00 per year. Their combined office and warehouse monthly payrolls, during the season, runs to $6500 per month.

All these figures, no doubt, are tedious, but I am endeavoring to show that there is a considerable organization at work constantly and unremittingly drawing on the natural resources of the lake. Nor are its efforts unrewarded. An average of the catches for the past two or three years will show that the annual production of herring alone is enormous, being no less than 3,000,000 pounds sold in the fresh or frozen state and 3,500,000 pounds sold in brine. At present prices, this great total may be valued at more than a third of a million dollars. Then there are upwards of 75,000 pounds of trout produced each year at a value of approximately ten thousand dollars. Of the other fish produced and shipped at Duluth the total would not be much more than 20,000 pounds. The fish brought into the Duluth port are taken between Duluth and the Canadian border and around Isle Royale.

Many people familiar with the fisheries I speak of, and some who are still engaged in them, will tell you that there are just as many herring in the lake as ever, or even that they are on the increase, but I must tell you, though I am an operator in the exploitation of these fish, that this is not the case. Further than that, I insist that they are diminishing very rapidly. It is true that the annual catch has not decreased as alarmingly as one might at first surmise from the above figures. But take into consideration the fact that the fishermen must now use several times as much twine to catch the same amount of fish; that they must venture out farther for them; that, with the increase in prices, more fishermen are working, and we see why the production has not decreased. But furthermore, (and here is the point I wish

especially to make) consider that scores and scores of tons of fish are now being caught on the spawning beds to be salted or frozen—which is a condition that did not formerly exist—and it is not difficult to realize that the end is in sight. This sort of thing cannot continue much longer or we will all automatically go out of business with the extinction of the herring, just as the famous catches of Lake Superior Whitefish are now gone, probably forever.

The remedy is simple and yet, on account of our foolish system of allowing each state to make its own game laws, this by no means small portion of the nation's natural resources is in danger of obliteration. In spite of the fact that it meant a temporary heavy financial loss to some of us last winter, we worked with the Minnesota State Game and Fish Commission to correct the condition, and did actually get passed a bill which increased the required size of the mesh to be used in the gill nets. This means that no more undersized herring can be legally caught in Minnesota waters. The law also establishes a closed season to protect the herring when spawning, this latter provision to become operative upon the passage of a similar law in Wisconsin. But right here is the difficulty; practically all the herring at the western end of the lake begin to congregate in the late fall in great schools, following the north shore westward until the spawning time arrives, which is usually about the 10th of November. At that time they appear in millions, not in Minnesota waters, but over the great muddy bottoms in the shallower Wisconsin waters at the extreme western end of the south shore of the lake. Here they congregate for three weeks for spawning and then, as suddenly as they appeared, they go.

The problem is now one for Wisconsin to deal with. The fishermen's lobby at Madison have side-tracked every effort made in that direction for years. They did pass one closed season bill, but instead of protecting the spawning fish they closed the season for a month before that period. It is well to protect the fish which are about to spawn, but it is certain that the damage that could be inflicted at that time is insignificant beside the other.

I am firmly of the opinion that migratory fish, like migratory birds, should be protected by Federal laws. These are not Minnesota's fish, nor Wisconsin's fish, nor Michigan's fish, though the

same fish traverse the shores of all these states. They need conservation as do the migratory birds. But, until we can get a national measure passed, something should be done to get Wisconsin into line. I urge this with full knowledge that my company will be one to suffer directly therefrom. It is not merely a conscience one must have to meet this condition, he must also have an eye for business, which is quite as important, and, unless I am very much mistaken, at the present rate of wholesale destruction of herring, in another five years the game will not be worth the candle.

INCREASING THE OUTPUT.

By W. O. Buck,
Neosho, Mo.

Mother Nature seems to be constantly trying to increase the output of fish and has adopted several details of plan to effect this. Enormous fecundity is perhaps the most important of these, but the concealment of eggs and young and the protection of both by parent fish work to the same end. Apparently these should soon carry the output to infinity, but in fact a limit is soon reached and lakes and streams and even the ocean are but sparsely stocked with fish and are easily depleted. In seeking the explanation of this we find it in the limitation of the food supply.

When we try to improve upon nature in the supply of young fish, the best we can do is to limp along her path and, since we cannot control fecundity, we must increase the number of breeders and give their offspring more protection and a better supply of food.

With trout and salmon running wild and handled only at spawning time the problem is comparatively simple, since the fish will be healthy and their numbers can be maintained with moderate effort. When trout must be bred and held in confinement, however, several new factors are introduced. The most conspicuous of these is crowding. Although some sorts of fish all through life, and perhaps all sorts at some stage, run together in schools, trout do so only for a short time. Every fish culturist knows that, as soon as they rise and begin to seek food, trout will separate as widely as they can. When food is thrown to them they rush at it from all directions and some are likely to get hurt when they meet.

Then, too, trout are stream fish and most artificial tanks or ponds fail to provide the best conditions for them. It is also necessary to offer them food which is entirely different from that on which the wild fish subsist. It is small wonder then that under such conditions the fish are not quite normal. Even so, we may and do attain a fair degree of success in propagating them, but when we try to do still better we must get back a little nearer to natural conditions.

Probably some part of the food should be such as the wild fish are accustomed to take and access to running water is doubtless desirable. All ways in which fish may be injured should be eliminated so far as may be. A brood stock may then be expected to live longer and, as older fish produce more eggs than young ones, the output will increase. But as the stock will inevitably grow less in numbers each year, the final resource for maintaining and increasing the output will be to add to the number of young breeders.

With pond fish, not artificially fed, the output may be increased by increasing the number of breeders, provided the young are promptly captured and given room elsewhere, but, since the limit of food supply is soon reached in stocking a pond with brood fish, more breeders may mean less output of young if all are left together. Not only will the old fish eat the young, but the young will eat one another. We all know this, but do not all agree as to what we shall do about it. In one instance about fifty black bass breeders were allowed to spawn in a pond of about a half acre, poorly supplied with plants, and the young allowed to remain till about the middle of July, when the pond was drawn and only thirteen were found. In his "Aquatic Plants in Pond Culture" Mr. Titcomb mentions an instance in which 20,000 young bass were placed by themselves in a half-acre pond in April and eight weeks later 6,000 well-grown fingerlings remained. In this case the pond was well supplied with plants and insect fish food.

It is probably clear to us all that young bass should be collected and distributed very early, not to make a record, but to give them their chance for life, which will be but slender if they are left in the brood ponds with the parent fish and especially if the ponds are stocked to the food limit or beyond. The question then comes as to the mode of collecting the young. Since the food supply for young and old depends on the maintenance of plant growth, it is necessary to adopt a method which will leave the plants undisturbed. Fortunately, young bass soon after leaving the nest will start on a tour of exploration around the margin of the pond, going in schools and these schools may be captured with a fine seine and placed in a tub or bucket, with small harm to fish or plants. Those that escape capture may be allowed to remain till fall, when the pond can be drawn.

Seining the whole pond does so much harm to the plants that it will probably be well to draw the pond in summer and remove both young and old fish, where this can be arranged. In practice it seems to me still better to protect the plants and use all the ponds the whole season, with the idea that the first and last essential of pond culture is food production. But it is not quite enough to protect volunteer plants, nor even to introduce plants at every opportunity. A selection should be made. Some are useful in protecting banks, where these are made of earth. Sawgrass, mint, flags, rushes, sagittaria, pontedaria, water-plantain, water-willow, water-purslane, etc., will do this, but not all are desirable.

Good qualities may be more than balanced by bad ones, as in the case of cattail flag, which will bind the bottom along the shore line very effectually and provide shade and shelter, but promptly becomes a nuisance by over-crowding and choking out everything else.

While along the margin a leading purpose of plants may be to protect the banks as well as provide shelter, for the body of the pond the object will be to furnish suitable conditions and pasture for the small creatures necessary for natural fish food. Here is where we all need more light. We do not certainly know just what the various kinds of fish need for food. Nor has it yet been made clear what conditions are most favorable for the production of any kind of food creatures. Our honored ex-president in attacking the problem of how how many food fishes it is possible for the Great Lakes to support included a study of aquatic plants and their dependence on the bottom for the elements of growth. Dr. Raymond H. Pond, as a result of his experiments, states that "the amount of plankton produced by bodies of fresh water is, other things being equal, in some inverse ratio proportional to the amount of its non-rooted vegetation and in some direct ratio proportional to the amount of its gross rooted vegetation." He goes on to draw the inference that: "In the stocking of ponds for fish culture, care should be taken to have a good soil for the bottom; not a stiff clay or sand, but a good loamy soil, such as is favorable for land plants. The species allowed to grow should be those which are known to possess roots and to be very dependent upon the soil, such as *Vallisneria spiralis*, the so-called fresh

water eel-grass, and *Potamogeton*, or pond weeds; not forms without roots, such as *Ceratophyllum*, or those less dependent upon the soil." (See Dr. Pond's "Relation of Aquatic Plants to Substratum," published in U. S. Fish Com. Bulletin for 1903.)

Realizing the need of plants in our ponds, most of us put in anything and everything which we can get to grow, and this is no doubt better than to plant nothing, but we may do still better by learning to know our friends from our enemies. As a guide to this, Titcomb's "Aquatic Plants in Pond Culture," published as Bureau of Fisheries Document No. 643 and included in the volume of bulletins for 1907 is invaluable. Bulletin No. 815, Moore's "Potamogetons in Relation to Pond Culture," with its full references to bibliography of allied subjects, also lets in the light for those who will use it.

Not all of us have access to these papers so the following suggestions are offered:

Keep plants out of trout ponds, but fill bass ponds with *Chara*, the *Potamogetons*, *Ranunculus*, *Philotria* (*Elodea*) and *Naias* in the main part of the pond and *Sagittaria* and rushes to bind earth banks.

Avoid cattail, water-lilies and parrotfeather.*

Handle your ponds so as to avoid injury to the plants and when a pond is drawn transfer the plants before they wilt to some other pond, unless all are abundantly supplied.

But all this deals only with the fishculturist's part of the problem—that of increasing the output of fish to be planted. The really important part is that of increasing the output of matured fish from our ponds and streams, public and private, and to solve this we must consider not only all that has gone before, but also the questions of what fish to plant and where and when and how.

Professor Needham, in his article on "Fish-culture" reprinted in his recent book, "Life of Inland Waters," emphasizes the importance of this part of the fishcultural problem, suggesting that "The hatcheries are raising fry and not fishes." "The planting of fry and fingerlings is effective where conditions permit of their growth." "The conditions in the wild are not such as yield much

* Dried specimens of some of the common pond plants mentioned were exhibited by the author.

advantage from this intensive propagation of the young." "Feeding fishes on the young of their own kind is not good husbandry." "Raising animals and their forage together is not good husbandry." These sentences are quoted out of their order and connection, but they furnish food for thought and material for discussion, because the line of argument is that fishculture must follow the lines of animal culture. But is there not a wide difference? It is not an economical use of land to make a pasture of it. Animals will trample down and destroy far more than they will eat. But fish do not do this. Then the assertion that it is not good husbandry to feed fishes on the young of their own kind sounds convincing, but is there not room for some modification of this statement in view of the fact that it is the rule for fishes to feed on their own young, and that the enormous fecundity of fishes is nature's admission of the fact? Or, shall we not still insist that it is, nevertheless, bad husbandry and that nature cannot help it and that therefore we should assist her in every way possible to increase production?

MIXING TROUT IN WESTERN WATERS.

By Aldo Leopold,
U. S. Forest Service, Albuquerque, New Mexico.

If a stream is stocked with 10,000 native trout, 10,000 eastern brook trout, and 10,000 rainbow trout, and granting that the conditions are suited to each of them, will that stream produce more or less pounds of trout per year than if stocked with 30,000 of any one of the three? In the west, at least, this is a live question which does not seem to have received serious study. It is the object of this paper to summarize such data as the United States Forest Service has been able to collect with the object of arriving at an answer. At least a tentative answer is needed as a guide to practice.

The question obviously involves variable local factors whose reactions are not susceptible to generalization. These variable factors may even preclude a general "yes" or "no" in answer to the question. Then, too little is known about the actual relations of the species to their environment and to each other to allow of reaching an answer by inductive reasoning. However, the question seems to involve the law of hybridization, from which important conclusions bearing on rules of practice can easily be deduced, and furthermore, the question can, to some degree, be illuminated empirically from actual observations.

The United States Bureau of Fisheries is authority for the statement that the trout hybrids so far studied have been fertile, but decreasingly so with successive generations. The Bureau believes, however, that hybridization is rare, but states that nobody knows exactly how rare. The law of hybrids would indicate that any trout hybrids which do occur between definite species are infertile, or at least less fertile than the pure stock. In either case the existence of hybrids would reduce the productive capacity of the water in which they occur. They must necessarily consume food which might be used by more fertile fish.

The actual observations of the writer, though meagre and confined to the southwest, are as follows:

1. Rainbow, eastern brook, cutthroat, and German brown trout have been indiscriminately mixed with the native black-spotted trout of our southwestern streams.

2. Where so mixed, it is commonly believed by fishermen that, (a), the rainbow and black-spotted trout have crossed

extensively, although the alleged hybrids have never been scientifically identified as such; (b) the German brown trout has not hybridized, but is preying extensively on the others and is becoming predominant; (c) the eastern brook-trout has not hybridized (for the obvious reason that they spawn in the fall and cannot hybridize with spring-spawning species).

3. It is the writer's impression that the streams stocked with several species do not "stand up" under the drain of heavy fishing quite as well as those with only one species. One of the most resistant streams known to the writer is Sabino Canyon in the Coronado National Forest, almost on the Mexican boundary. It was stocked once with eastern brook trout in 1908, has been heavily fished ever since, and showed no sign of giving out until this year. Much less resistant is the Pecos River in the Santa Fe National Forest, a much larger stream. It has been stocked every year with black-spotted, rainbow or German brown trout, and is no more heavily fished, in proportion to its size, than the Sabino. These impressions are, of course, merely indicative.

It appears therefore that available knowledge on the question of mixing species, may be summarized as follows:

1. Species of trout spawning at the same time may hybridize. More knowledge is needed on when and to what extent.

2. These hybrids are less productive, and therefore less desirable, than pure stock. More knowledge is needed on how much their reproductive capacity is reduced.

From the foregoing conclusions, the Southwestern District of the Forest Service has arrived at and is now adhering to the following rules of practice in stocking trout waters in the National Forests of Arizona and New Mexico:

1. Nature, in stocking trout waters, sticks to one species. The Forest Service will do likewise where mixing has not already occurred.

2. Empty waters will be stocked with the species that seems most suitable. Where there is danger of depletion through heavy fishing, avoid rainbows. Where there is danger of the water being too warm, avoid black-spotted and eastern brook-trout. Where a lake is large or mud-bottomed or warm or otherwise liable to produce large non-rising fish, avoid the native black-spotted trout.

3. Stocked waters will not be further mixed. Restock with the best adapted species, the native species always preferred.

IMPROVE THE CANNED FISH PRODUCT.

By K. Hovden,
Monterey, California.

Under the present business conditions and with a scarcity of tin, it behooves the canners of this country to furnish the public with as good products as possible, instead of wasting time and tin-plate in packing inferior goods to become a glut on the market, which is a tendency shown by many canners at the present day.

Many of our numerous canners do not seem to understand the first principles of cooking, which is an essential thing for any canner aside, perhaps, from those engaged in canning salmon. The process of salmon canning is more or less mechanical, as it is not processed nor prepared for the table in any other way but by cooking in the tin.

Sardines require greater skill and more training. The fish vary in the amount of fat and protein according to the season and, in the writer's opinion they should not be canned in the winter and early spring, when they are spawning, as they are then too poor in food value and contain scarcely any fat.

As the Department of Agriculture is trying to educate the people in the preparation of food for cattle, hogs, etc., it would not be out of the way for the proper authorities to teach the canners how best to prepare canned fish for human consumption. It might be very interesting if samples of the products of various packers could be analyzed for comparison. If then, it were required to sell the product according to analysis, all packers would be compelled to put up a good article, or the people would not buy their products. Sometimes there is more waste product than digestible food in a can and the public should not unwittingly be taxed with a costly container holding such a product.

Most of our edible fish are being utilized, but the manner in which they are prepared for the public is often not on a scientific basis. The products should be standardized, the government should maintain schools for the education of canners and, in fact, no cannery should be permitted to operate unless the man in charge of the plant has sufficient education and knowledge of scientific methods of preparing food products for human con-

sumption. In this way we should be able to meet foreign competition here and to conquer markets outside of America. We have a vast supply of fish which, in other countries really cost more fresh than we can produce it for in tins.

In Europe the tins and sizes of fish are standardized. In Norway the packers agreed not to pack winter fish, so as not to injure the reputation of Norway sardines. American packers, especially in the present crisis, ought not be averse to helping the people and the government in saving tin plate, by packing only a nourishing food product. In this way they may serve the country by serving the public right, even if the immediate result should not be so profitable.

FEDERAL CONTROL OF FISHING IN THE MISSISSIPPI RIVER.

By M. N. Lipinsky,
Winona, Minn.

Commercial fishing on the upper Mississippi has for some time been considered a dishonorable trade, at least to a certain extent. This is due to the misunderstanding of laws, rather than to wilful violations, but it is not just to discredit the business of all engaged in commercial fishing on account of the acts of a few, especially when such great results are obtained with very little actual cost to the respective states or to the Federal Government.

The carp is the principal fish of the upper Mississippi and requires the least attention, for it is a prolific breeder, grows rapidly, is very good eating when properly prepared, and is of great value to the states concerned and to the commercial fishermen.

The fish commonly known as buffalo is also a very valuable food fish, and a native of the Mississippi River. These two are the principal fish, speaking commercially, of the Mississippi, and by proper propagation, either artificially or naturally, the Mississippi would produce at least ten times the amount of food fish it is producing today.

The greatest damage to natural breeding places is caused by the construction of railroads, dams and dikes which allow the

fish to enter in high water, but shut them off later and cause suffocation in winter. Such places should be attended to first, as I believe here lies the greatest danger to the small fish.

If I may be allowed to suggest a good, permanent way to conserve the small fish which get into the land-locked lakes and bays in high water, it would be to use steam shovels or ditching machines and connect the ponds and lakes with ditches that deepen as they run into the river. In a good many places artesian wells could be used very successfully. The different states have different ideas and opinions regarding fish and game laws and to avoid trouble we should have federal laws on interstate waters—that is, specifically, a uniform law for all the states bordering on the upper Mississippi.

We all know there is a question as to jurisdiction on the Mississippi, but be it state or federal, there should be something done to aid in the already valuable work being done in seining out some of the land-locked ponds. There are millions of these small fish that suffocate each winter along the Mississippi valley and if given proper protection from the heavy winter killings, as we commonly call it, we would have an abundance of all the different varieties of fish. I wish I could produce the record of the exact amount of fish taken out commercially from these waters each year, but it is impossible at this time, as most fishermen do not keep any records of their catches.

I make no criticism of the good work already done, but merely express my view of the conditions as seen in my immediate vicinity, with some suggestions as to their improvement. There are many arguments in favor of federal control of the finest fishing stream in the world, the Mississippi River.

THE GENERAL ROUTINE OF A TROUT HATCHERY.

By R. L. Ripple,
Bayfield Fish Hatchery, Bayfield, Wis.

Where can there be a line of work more fascinating, or less monotonous as a daily vocation than that of a brook and lake trout hatchery, where many millions of both varieties are handled every year? The trout hatchery is mentioned in this instance in preference to those where other varieties of fish are handled, because the breeders are reared from infancy and kept in the ponds the year round, and must be fed and cared for and kept in a good condition. The fertility of the eggs and the vitality of the little fish which result from the spawning season each year, depend on the manner in which the adult trout have been fed and otherwise cared for, the same as with stock or anything else.

Where can there be a more contented man than he who in the fall of the year, as the spawning season approaches, removes the thousands of trout breeders of various ages and sizes to the hatchery spawning raceways, and finds them to be fit and ready for the yearly production? The spawning is the fish man's harvest and the results of a year's careful and painstaking work are at hand. Perhaps during the year there were many trials and worries, but the condition of the fish, as they are removed from the ponds to the spawning races, shows that all is well.

However, strive as the hatchery man will to prevent it, there is always a certain loss of breeders in the stock fish ponds that is put down as unaccountable. We count each year, one by one at spawning time, all the fish put into the ponds. We keep an accurate account of all dead fish removed from each pond during the year, but still there is always a shortage, for the fish in the ponds have many enemies, such as the blue heron, muskrat and kingfisher. The blue heron is one of the greatest consumers of fish that we have to contend with, as it does its work at night, and I have had very good reason to believe that that great vegetarian, the muskrat, will go on a meat diet when he wants to go fishing for a change. There is a much larger number of trout and trout fry consumed every year from the ponds than many people have any idea of.

Our station at Bayfield has a capacity of about 20 double hatching troughs, 11 boxes long, 22 boxes to the double trough, each box holding 7 trays at two quarts per tray. When the hatchery is filled with its quota of lake trout, brook trout and brown trout eggs, it means many millions. Only those of you who have the thing to do can realize what effort it takes to fill these many stations, especially in the case of the lake trout, as they must be netted in the Great Lakes by the commercial fishermen in the late fall. Only one who has experienced the work can tell what a fight with the elements and unfavorable conditions it means to bring home each fall this harvest of spawn.

The spawning season over, the responsibilities grow heavy on the hatchery men. Millions of fish lives are contained in those eggs. The running water is passing over them, and must be kept passing. The ten to twenty-five per cent of infertile eggs must be removed as they begin to decay. Instead of the time-worn plan of picking them out with tweezers by hand, we use the more modern method, the brine box. In this the trays are placed, several at a time, the brine solution allowing the bad eggs, which are lighter, to come to the top, where they are scraped off with a small net. Two men, in the same time, now do what it formerly took eight or ten men to do.

For 110 days, on the average, these millions of eggs must remain on the hatchery trays, bringing the hatching season along into March or the latter part of February, in our locality. When the lake trout fry are ready, being some six weeks old, they are taken out in boats and planted on the reefs and spawning beds, where they would naturally hatch. I can not attempt to tell in so brief an article what their lot would have been had they remained on those reefs for 110 days. We have prevented, however, some of that tremendous loss that occurs yearly in nature.

The millions of brook and other trout fry are now placed in the various feeding tanks and rearing ponds, and again, as always, the hatchery man has his work cut out for him.

Shipping time is now at hand. The tanks are full of fry, taking their food six times a day, ready to go out into the streams, and it is with much rush of cans and men, etc., that they are started out on life's journey. Every outgoing baggage car must take its shipment or shipments of trout. Not only the baggage

cars do this, but also our commodious State Fish Car "Badger," which carries 200 of our ten-gallon shipping cans at a trip. Each can contains the proper amount of fry according to distance it is to travel, and has a chunk of ice on the cover to drip and keep the water at the right temperature in the can below.

The fish messengers are sent out with their alloted cans of fry, holding them over perhaps at some junction, or, through some delay, held up maybe a day at the railway station until the fish are delivered to the applicants; or they may have orders to plant the fish in the headwaters of a stream as soon as they can be gotten there. Seldom indeed does a complaint come in that the fish were not planted in good condition.

Every can carried in a given shipment contains the same number of fry or fingerlings. We measure all our fry by dry measure at time of shipping, by means of small screen-bottom dippers or strainers, each holding a certain number of fry or fingerlings at different ages. I know of no method more accurate or more easily operated than the above for measuring the fish put into each can.

As the hatchery tanks of fry are thinned out through shipping they are filled again from the hatching troughs with those that are coming on daily to the shipping age and size. They do not hatch all at once nor reach the shipping condition at the same time.

The several hundred thousand fry to be kept for fall shipment are now removed to the outside rearing ponds, where they will have more room, and the feeding, from six times a day, is cut gradually to twice a day.

The feeder is very careful that the fry all get some of the food, scattering the little particles of meat or strained "plucks" over the whole surface. He knows many anxious moments and days until all are feeding well and they start to grow rapidly. If he can see no dead ones on the clean gravel bottom, and they work to the head of the pond and fight the current, even the fish hatchery man feels some little joy in life.

The rearing ponds above referred to are small in size, many of them being almost square, while others are oblong, etc. We find, however, that the most satisfactory ponds are those about 8 feet wide, and from 30 to 50 feet in length, with a depth of 18 inches to 2 feet of water.

If one can arrange, as we are able to at Bayfield, to have the water fall a foot or more into each pond, it will help to aerate the water and also it creates a natural condition much appreciated by the fish. These long and rather shallow ponds give the desired current. They are also more easily covered with shades made of two by fours, in the form of gable-roof frames over which building paper or tar paper is stretched. We formerly did not use these, as we have considerable natural shade from trees, but we were greatly bothered with algae in the water. The shades do away entirely with all this trouble, giving the fish all the available room in the ponds and making it more agreeable when the time comes for removing them for sorting or shipping. Formerly this green "moss" would be seined in with the fish, getting into their gills, and causing no small loss.

Nothing can be more ideal for a bottom to these ponds than a layer of clean gravel, which can be raked over and over when cleaning, allowing the water to work through it and making for more sanitary conditions.

We have, now nearing completion, six fingerling or fry ponds, each 8 feet wide, 50 feet long and 40 inches deep, and the water will fall about eighteen inches into each pond. These are being built beside our Birch Run Springs stream, among the densest of natural shade. It is an ideal situation. We have tested the water for several years past, because we trout men know only too well that fine looking water, clear and beautiful, does not always assure success. This Birch Run water is the softest in use at any of our trout hatcheries.

We aim to raise at Bayfield each year quite a number of brook trout fingerlings, shipping many of them along in October, but saving a certain number each year to replenish our stock fish ponds and also those of our other trout hatcheries where the conditions are less favorable for raising fingerlings. We have nine hatcheries in our state, three of them being devoted to brook, rainbow, and brown trout. The Bayfield plant is more successful at this line than the others, in a number of ways, because the water is much softer than that at the other hatcheries.

Our Wild Rose Hatchery has the most beautiful water in abundance, natural shade, plenty of fall, sandy, clean locality, where the trout streams are the best in the state for fishing,

where there could hardly be a doubt left as to its suitability for the propagation of trout, yet here we have met with conditions unfavorable to an extent undreamed of. But if we can get the trout past the stage of absorbing the yolk sac, our trouble is past. The eggs that are taken there annually—some two to three millions—are shipped to the Bayfield hatchery, where they hatch into the strongest of fry and we have no losses in the fry stage.

The man with the feed pail and dipper, the man who selects the livers and plucks, the man that knows how to spread the feed and do a thousand other things properly, is truly the man responsible for the results, as it is with a successful stock raiser. For months and years he stands guard over these things and he may know little else and care less. It is confining work, but still very fascinating.

The fry are fed five or six times a day, at first, in the hatchery vats, with very finely ground food composed of one-half liver and one-half sheep plucks. We find the plucks an excellent food, because the fine particles float, giving the little fellows plenty of time to get it, whereas, the liver will settle quickly to the bottom. However, the fry that have learned how to feed take it before it reaches the bottom. This finely ground food must all pass through a sieve before being mixed with the water for feeding, to make sure that there will be no pieces large enough to harm the fry. It is fed a little at a time and often at first, and how they do eat! During the five or six weeks they have been in the hatchery fry troughs, they have been absorbing nourishment from the natural food sac. They are eager now for a change of diet, and the little particles of liver and plucks are taken eagerly. What fun it is to see them retain their places at the headwaters, where the current is swift, and work for the food. All these things work into a trout man's system, and become a part of him.

Some of these little fingerlings are now growing faster than others and some of them are destined to be, at maturity, much larger than others of the same age. These larger ones must be separated from the others, or else there will be a tremendous loss during the late summer, for the large devour the small, especially in the brook trout. Those who maintain that the rainbows are eternally eating up all the brook trout are, I believe, mistaken to a great extent. We all know the rainbow is a very

much hardier fish in suitable waters. We know it stands more abuse and is not subject to the copepod parasite that yearly carries off quite a number of our brook trout of two years of age and over in the wildest of streams, as well as in hatchery ponds. We do not remove the rainbow fry to sort, because we have not had any great loss through cannibalism, though there is just as much irregularity in size as among the brook trout at a given age. There is, however, one feature against the rainbow, in comparison with the brook trout, in that we find on the average a larger number of infertile eggs.

A few hundred thousand of these little beauties in a small space make a sight to behold, rolling to the surface to feed and sparkling in the sunlight with their small red fins and tails. The water fairly crackles as those little bodies hit the surface in masses.

The large breeders in the ponds will follow the feeder and his pail around the ponds and even come to the landing place and take food from his hand. One may see thousands of these trout at sunset jumping for flies, sometimes leaving the water three to five feet. To witness all this is living.

Allow me to add in conclusion that we have at Bayfield one of the finest equipped hatcheries in this country, in ponds, in buildings, in water and in grounds that compare with the best kept parks in the cities, and we are proud of our work.

PRIZES OFFERED FOR CONTRIBUTIONS.

For the purpose of stimulating interest in fisheries problems and the work of the American Fisheries Society the officers of the Society have decided to offer prizes for the best contributions. Three phases of fisheries work are included, the cultural, commercial and the biological, under the terms outlined in the statement by President O'Malley which follows.—EDITOR.

WASHINGTON, D. C., May 23, 1918.

To the Members of the American Fisheries Society:

In order to develop interest in fish culture and related subjects, and to stimulate expression regarding them, the American Fisheries Society has through its President and Executive Committee, decided to offer three prizes of $100 each, to be awarded at its meeting in New York City on September 9, 10 and 11, 1918, as follows:

1. For the best contribution on fish culture; either new or improved practical fish cultural appliances, or a description of methods employed in the advancement of fish cultural work.

2. For the best contribution on biological investigations applied to fish cultural problems.

3. For the best contribution dealing with the problems of the commercial fisheries.

A committee of three members of the Society, one a practical fish culturist, one a scientist and one a practical commercial fisherman, to be appointed by the President, will pass upon the material submitted. The conditions governing the competition are as follows:

1. Any person who is a member of the Society, or who duly qualifies as a member prior to September 1, 1918, may compete for the awards.

2. Each competitor is to notify Mr. John W. Titcomb, Recording Secretary, Albany, N. Y., before September 1 of the particular prize for which he intends to compete.

3. Each paper or exhibit offered in competition to be in the custody of the Secretary of the Society on or before September 3, 1918.

4. Each device, apparatus,. process, or method offered for an award is to be represented by a sample, model or illustrated description, each to be accompanied by a complete statement of the points for which an award is asked.

The Society is to reserve the right to publish any papers or photographs submitted in competition prior to their publication elsewhere; provided, however, that in the event of failure to publish within nine months after the meeting the author will be at liberty to publish when and where he may elect.

5. The Committee appointed by the President is to determine the competitors who are entitled to awards, and the decision of the committee is to be final.

6. In order to obtain additional information, if desired, the committee may call before it persons who may have entered the competition, and also other persons.

7. If in the judgment of the committee no paper submitted on a given subject comes up to the standard decided upon by it the author shall not be entitled to any award.

8. The committee is to make its final report to the Society not later than the morning session of the third day of the meeting.

It is hoped that every fish culturist, biologist and persons dealing with the problems connected with the commercial fisheries will make a special effort to present a paper on the subject in which he is interested, as anything that will increase the efficiency of fish cultural operations or the output of the commercial fisheries is highly important at this particular time.

Very respectfully,

HENRY O'MALLEY, *President.*

THE 1918 MEETING.

Don't Forget the Annual Meeting to be held in New York City, September 9th, 10th and 11th.

Can you not secure for the Society one or more new members? Every man engaged or interested in fish culture should be a member of the Society. The fact that a man is unable to attend meetings is no excuse. The publications alone are worth more than the price of admission. If you cannot send applications, please suggest names to whom the secretary may write.

JOHN W. TITCOMB, *Secretary*,
Albany, N. Y.

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U. S. National Museum

TRANSACTIONS

OF THE

AMERICAN FISHERIES SOCIETY

SEPTEMBER, 1918

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The American Fisheries Society

Organized 1870 Incorporated 1910

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TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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1917-1918

Edited by Raymond C. Osburn

SEPTEMBER, 1918

Published Quarterly by the Society

COLUMBUS, OHIO

CERTIFICATE OF INCORPORATION OF THE AMERICAN FISHERIES SOCIETY

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish with power:

(*a*) To acquire, hold and convey real estate and other property, and to establish general and special funds.

(*b*) To hold meetings.

(*c*) To publish and distribute documents.

(*d*) To conduct lectures.

(*e*) To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

(*f*) To acquire and maintain a library.

(*g*) And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER	(Seal)
THEODORE GILL	(Seal)
WILLIAM E. MEEHAN	(Seal)
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Recorded April 16, 1911.

AMERICAN FISHERIES SOCIETY

Organized 1870

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

PRESIDENTS, TERMS OF SERVICE AND PLACES OF MEETING.

1.	William Clift	1870–1872	New York, N. Y.
2.	William Clift	1872–1873	Albany, N. Y.
3.	William Clift	1873–1874	New York, N. Y.
4.	Robert B. Roosevelt	1874–1875	New York, N. Y.
5.	Robert B. Roosevelt	1875–1876	New York, N. Y.
6.	Robert B. Roosevelt	1876–1877*	New York, N. Y.
7.	Robert B. Roosevelt	1877–1878	New York, N. Y.
8.	Robert B. Roosevelt	1878–1879	New York, N. Y.
9.	Robert B. Roosevelt	1879–1880	New York, N. Y.
10.	Robert B. Roosevelt	1880–1881	New York, N. Y.
11.	Robert B. Roosevelt	1881–1882	New York, N. Y.
12.	George Shepard Page	1882–1883	New York, N. Y.
13.	James Benkard	1883–1884	New York, N. Y.
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16.	W. M. Hudson	1886–1887	Chicago, Ill.
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18.	John H. Bissell	1888–1889	Detroit, Mich.
19.	Eugene G. Blackford	1889–1890	Philadelphia, Pa.
20.	Eugene G. Blackford	1890–1891	Put-in-Bay, Ohio.
21.	James A. Henshall	1891–1892	Washington, D. C.
22.	Herschel Whitaker	1892–1893	New York, N. Y.
23.	Henry C. Ford	1893–1894	Chicago, Ill.
24.	William L. May	1894–1895	Philadelphia, Pa.
25.	L. D. Huntington	1895–1896	New York, N. Y.
26.	Herschel Whitaker	1896–1897	New York, N. Y.
27.	William L. May	1897–1898	Detroit, Mich.
28.	George F. Peabody	1898–1899	Omaha, Neb.
29.	John W. Titcomb	1899–1900	Niagara Falls, N. Y.
30.	F. B. Dickerson	1900–1901	Woods Hole, Mass.
31.	E. E. Bryant	1901–1902	Milwaukee, Wis.
32.	George M. Bowers	1902–1903	Put-in-Bay, Ohio.
33.	Frank N. Clark	1903–1904	Woods Hole, Mass.
34.	Henry T. Root	1904–1905	Atlantic City, N. J.
35.	C. D. Joslyn	1905–1906	White Sulphur Spgs, W. Va.
36.	E. A. Birge	1906–1907	Grand Rapids, Mich.
37.	Hugh M. Smith	1907–1908	Erie, Pa.
38.	Tarleton H. Bean	1908–1909	Washington, D. C.
39.	Seymour Bower	1909–1910	Toledo, Ohio.
40.	William E. Meehan	1910–1911	New York, N. Y.
41.	S. F. Fullerton	1911–1912	St. Louis, Mo.
42.	Charles H. Townsend	1912–1913	Denver, Colo.
43.	Henry B. Ward	1913–1914	Boston, Mass.
44.	Daniel B. Fearing	1914–1915	Washington, D. C.
45.	Jacob Reighard	1915–1916	San Francisco, Cal.
46.	Geo. W. Field	1916–1917	New Orleans, La.
47.	Henry O'Malley	1917–1918	St. Paul, Minn.

* A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

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The American Fisheries Society

LIST OF MEMBERS, 1917-1918

Showing Year of Election to Membership

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'08 Antipa, Prof. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.
'06 Besana, Giuseppe, Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy.
'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.
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'89 Olsen, Dr. O. T., Grimsby, England.
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'84 Raveret-Wattel, C., Director of Aquicultural Station at Nid-de-Verdier, 20 Rue des Acacias, Paris.
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'10 Linton, Dr. Edwin, Washington and Jefferson College, Washington, Pa.
'16 Lipinsky, M. N., Winona, Minn.
'06 Locher, Wm., Kalamazoo, Mich.
'12 Loesch, H. C., Colorado Springs, Colo.
'15 Lowell, Mansfield, San Francisco, Cal.
'16 Lowrance, W. J., Berwick, La.
'16 Ludwig, John, Grand Isle, La.
'16 Lycan, Frank S., Bemidji, Minn.
'98 Lydell, Dwight, Michigan Fish Commission, Comstock Park, Mich.

'10 Mabie, Charles H., Maywood, N. J.
'13 MacCallum, G. A., M. D., 981 Madison Ave., New York, N. Y.
'17 MacLachlan, Dr. Chas., Pres. Game and Fish Board, New Rockford, N. D.
'11 McDonald, Carl K., Armstrong, Okla.
'14 McDonald, E. B., Ligget and Myers Tobacco Co., St. Louis, Mo.
'03 McDougal, J. M., Gunnison, Colo.
'12 McReynolds, B. B., Water Superintendent, Colorado Springs, Colo.
'17 Mack, John E., Carson City, Nev.
'03 Mahone, A. H., U. S. Bureau of Fisheries, Quilcene, Wash.
'15 Mailliard, Joseph, 1815 Vallejo St., San Francisco, Cal.
'80 Mallory, Charles, Port Chester, N. Y.
'10 Mannfeld, Geo. N., Indianapolis, Ind.
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'13 Merrill, Arthur, Wilkinsonville, Mass.
'99 Merrill, M. E., Pittsford, Vt.
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'17 Miller, Dan E., Constantia, N. Y.
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'13 O'Hara, Joseph, Pleasant Mount, Pa.
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'04 Pope, T. E. B., Curator, Public Museum of the City of Milwaukee, Milwaukee, Wis.
'06 Porter, Richard, Board of State Fish Commissioners, Paris, Mo.
'09 Postal, Fred, State Board of Fish Commissioners, Detroit, Mich.
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'17 Rasmussen, Dr. A. T., Talrosse, Wis.
'93 Ravenel, W. de C., U. S. National Museum, Washington, D. C.
'16 Ray, J. E., Alexandria, La.
'13 Redwood Library, Newport, R. I.
'09 Reed, Dr. H. D., Cornell University, Ithaca, N. Y.
'13 Reidel, F. K., Pleasant Mount, Pa.
'93 Reighard, Prof. Jacob E., University of Michigan, Ann Arbor, Mich.
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'16 Rowe, Wm. H., West Buxton, Me.
'16 Royce, James, DéBruce, Sullivan County, N. Y.
'11 Ruckman, Chas. W., U. S. Bureau of Fisheries, Homer, Minn.
'14 Russell, Geo. S., Bank of Commerce of N. A., Cleveland, Ohio.
'13 Russell, J. R., U. S. Bureau of Fisheries, Birdsview, Wash.
'13 Ryan, Calvin D., U. S. Bureau of Fisheries, Concrete, Wash.

'16 St. Martin, Xavier H., Houma, La.
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'11 Walker, Dr. H. T., 210 Main St., Denison, Texas.
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'15 Weise, Engleberg, Seattle, Wash.
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'01 Wilson, C. H., Glen Falls, N. Y.
'11 Wilson, J. S. P. H., Chairman, Board of Inland Game and Fish Commissioners, Auburn, Me.
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'99 Wires, S. P., U. S. Bureau of Fisheries, Duluth, Minn.
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'05 *Wolters, Chas. A., Oxford and Marvine Streets, Philadelphia, Pa.
'97 Wood, C. C., Plymouth, Mass.
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'14 Work, Gerald, Perkins Hill, Akron, Ohio.
'84 Worth, S. G., 518 Colonial Ave., Norfolk, Va.

'09 YERINGTON, EDWARD B., Board of Fish Commissioners, Carson City, Nevada.
'16 YOUNGER, R. J., Houma, La.

'99 ZALSMAN, P. G., Grayling, Mich.

Supplementary List, Dating from 1918 Meeting.

BAILEY, ARTHUR T., Nashua, N. H.
BELLISLE, J. A., Inspector General of Fisheries and Game, Quebec, Canada.
BILISOLY, E. NASH, 517 Law Bldg., Norfolk, Va.
BRIGGS, ARTHUR, Supt. Maine Hatcheries, Winthrop, Me.
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CAYAHOGA COUNTY SPORTMENS' ASSOCIATION, (JOHN L. ALNUTT, President), Auburn, N. Y.
COYKENDALL, EDWARD, 22 Ferry St., Kingston, N. Y.
DURANT, DR. E. W., Chairman, Board of Fisheries of S. C., Georgetown, South Carolina.
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HAWKS, S. B., County Warden and Hatchery Supt., Bennington, Vt.
IRONDEQUOIT FISH AND GAME ASSOCIATION, (J. W. JOHNSTON, Cor. Sec.), Rochester, N. Y.
KIPPENDORF, CARL H., Sagamore and New Sts., Cincinnati, Ohio.
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MOORE, EMMELINE, Vassar College, Poughkeepsie, N. Y.
MORLEY, E. C., Sodus Point, N. Y.
MULLIN, WM. K., Bridgeport, Conn.
NEEDHAM, PROF. JAS. G., Cornell University, Ithaca, N. Y.
REW, JOHN R., Commissioner of Fisheries, Norfolk, Va.
RICHARDSON, A. P., Supt. of Fish Hatchery, Canaan, Vt.
ROBERTSON, ALEXANDER, Dominion Salmon Hatchery, Harrison Hot Springs, B. C., Canada.
SEAMAN, FRANK, Napanoch, N. Y.
SUN, DR. F. T., President, School of Fisheries, Tientsin, China.
THOMPSON, W. F.

RECAPITULATION.

Honorary	68
Corresponding	14
Patrons	53
Active	624
Total	759

CONSTITUTION

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERSHIP

Active Members.—Any person may, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership.

Any library, sporting or fishing club, society, firm or corporation may upon two-thirds vote and the payment of the regular annual fee, become a member of this Society and entitled to all its publications.

Life Members.—Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, become a life member of this Society, and shall thereafter be exempt from all annual dues.

Patrons.—Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50.00,

may become a Patron of this Society with all the privileges of a life member, and then shall be listed as such in all published lists of the Society. The money thus received shall become part of the permanent funds of the Society and the interest alone be used as the Society shall designate.

Honorary and Corresponding Members.—Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several States shall be honorary members of the Society.

Election of Members Between Annual Meetings.—The President, Recording Secretary and Treasurer of the Society are hereby authorized, during the time intervening between annual meetings, to act on all individual applications for membership in the Society, a majority vote of the Committee to elect or reject such applications as may be duly made.

ARTICLE III

SECTIONS

On presentation of a formal written petition signed by one hundred or more members, the Executive Committee of the American Fisheries Society may approve the formation in any region of a Section of the American Fisheries Society to be known as the ——— Section.

Such a Section may organize by electing its own officers, and by adopting such rules as are not in conflict with the Constitution and By-Laws of the American Fisheries Society.

It may hold meetings and otherwise advance the general interests of the Society, except that the time and place of its annual meeting must receive the approval of the Executive Committee of the American Fisheries Society, and that without specific vote of the American Fisheries Society, the Section shall not commit itself to any expression of public policy on fishing matters.

It may further incur indebtedness to an amount necessary for the conduct of its work not to exceed one-half of the sum received in annual dues from members of said section.

Such bills duly approved by the Chairman and Recorder of the Section shall be paid on presentation to the Treasurer of the American Fisheries Society.

ARTICLE IV

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an editor, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

Vice-presidents of sections are expected to present reports at each annual meeting.

ARTICLE V

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE VI

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
   a. President.
   b. Secretary.
   c. Treasurer.
   d. Vice-Presidents of Divisions.
   e. Standing Committees.
5. Committees appointed by the president.
   a. Committee of five on nomination of officers for ensuing year.
   b. Committee of three on time and place of next meeting.
   c. Auditing committee of three.
   d. Committee of three on programme.
   e. Committee of three on publication.
   f. Committee of three on publicity.
6. Reading of papers and discussion of same.
   (Note—In the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VII

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

EDITORIAL.

The Annual Meeting. On September 9, 10 and 11, the forty-eighth annual meeting of the Society was held in the Waldorf-Astoria Hotel, New York City, with an attendance of about seventy-five members. Twenty-eight new members were elected bringing the total active membership to six hundred and twenty-four.

The meeting was marked by unusual earnestness in the consideration and discussion of problems. It may be safely said that never in the history of the society has there been a program more thoroughly scientific in character, nor, at the same time, one of greater importance in practical fisheries work.

The important problem of pollution, the discussion of which was led by Prof. Henry B. Ward's paper, naturally absorbed its full share of time at the meeting. The question of foods for the artificial feeding of fishes also evoked lively discussion, centering around important papers by Prof. G. C. Embody of Cornell University, and Dr. Sergius Morgulis of Creighton University.

The paper by Prof. Embody, entitled "Results of Some Trout Feeding Experiments," was awarded the prize among the competitive contributions on "Fish Culture." Dr. Morgulis was the recipient of the prize in "Biological Investigation" on his paper, "Studies on the Nutrition of Fish—Experiments on Brook Trout." No prize was awarded in the class "Commercial Fisheries," the only paper offered in competition being later withdrawn as not meeting the requirements. The offering of these prizes is a new feature of the Society's work and they will probably be offered again. The interest from the Permanent Fund—the accumulated fees of Patrons—provided the money for the prizes, one hundred dollars in each of the classes mentioned.

Officers for 1918–19 were elected as follows: President, Mr. M. L. Alexander, New Orleans, La.; Vice-President, Mr. Carlos Avery, St. Paul, Minn.; Recording Secretary, Mr. John P. Woods, St. Louis, Mo.; Treasurer, Mr. A. L. Millett, Gloucester, Mass.; Editor, Prof. Raymond C. Osburn, Columbus, Ohio; and Chairman of the Executive Committee, Mr. N. R. Buller, Harrisburg, Pa.

A full account of the meeting will appear later in the Proceedings.

R. C. O.

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Vol. XLVIII No. 1

Division of Fishes,
U. S. National Museum

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OF THE
AMERICAN FISHERIES SOCIETY

Smithsonian Institution
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National Museum

DECEMBER, 1918

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The American Fisheries Society

Organized 1870 Incorporated 1910

Officers for 1918-1919

President.....M. L. Alexander, New Orleans, La.
Vice-President.....Carlos Avery, St. Paul, Minn.
Recording Secretary.....John P. Woods, St. Louis, Mo.
Cor. Secretary....Chas. H. Townsend, The Aquarium, N. Y. C.
Treasurer.....A. L. Millett, Gloucester, Mass.
Editor.....Raymond C. Osburn, Columbus, Ohio

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W. H. Rowe.....West Buxton, Me.
W. E. Barber.....Lacrosse, Wis.
W. H. Killian.....Baltimore, Md.
Carl Westerfeld .....San Francisco, Cal.

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of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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THE ELIMINATION OF STREAM POLLUTION IN NEW YORK STATE.

By Henry B. Ward,
University of Illinois.

Mr. President, and Gentlemen of the Society:

The importance of the problem of stream pollution may be judged from a recent statement by one of the members of the United States Food Administration, charged with responsibility for the fish foods and their distribution, who said that among all the suggestions which had been made from all the states of the Union with reference to the improvement of the fisheries and the increase in the product, more than sixty per cent of them dealt with stream pollution.

The situation is naturally worse in the seacoast states, in the older states and in the manufacturing states. It naturally is least significant in the parts of the country that lie at a distance from the ocean and removed from centers of manufacture. You will easily recognize that in the heart of the Adirondacks stream pollution is not a serious problem. Most of you who read the newspapers are aware of the fact that New York City regards stream pollution as a very important problem from the standpoint of the municipality and its activities, and no one connected with fish work who comes in contact with the Hudson will question that the yield of that stream and its value as an asset for the state and the nation are greatly reduced by the conditions that exist in the stream at the present time.

The importance of the question was such and my interest in the biological side of it, which I had studied incidentally for some time, was so great, that I accepted with pleasure the invitation from the Conservation Commission of New York State to spend the summer working with them to bring together the data, to organize them into a plan, and to see what steps might be practicable in attempting to reach a solution of the problem, a removal of the difficulty; and I want here to acknowledge publicly, if I may, the courtesies that I have received at the hands of the Commission. Every one of the gentlemen with whom I have

come in contact has manifested the greatest sympathy and interest in the problem, and has gone out of his way to make me acquainted with facts, and to assist me in analyzing conditions and in formulating a plan for the change of these conditions.

We have been accustomed from the engineering and scientific standpoint to separate wastes into two types, speaking of domestic sewage on the one hand and industrial wastes on the other hand, domestic sewage consisting, briefly speaking, of waste discharges of an organic character; materials that are rapidly attacked under natural conditions, transformed into substances that serve as food for different kinds of organisms, and in the processes of nature are soon removed, or made over into useful substances; the industrial wastes on the other hand consisting of chemical materials, dyes and acids, and other substances entirely foreign to the water under natural conditions, substances which remain often unchanged for considerable periods of time; and their effects consequently are felt over a greater extent of the stream than in the earlier case. Further, their effects are very much more serious and are exerted often through the inflow of a smaller amount of material.

Now the classification is all right from a scientific and practical point of view, but it is all wrong from the facts in the case; and if you stop to think for the moment you will see what is meant. This I consider of fundamental importance in our discussion of the problem, because it has been customary in writings to set aside domestic sewage, to say that it was under the control of Boards of Health, that it was rapidly made over by processes of nature, that it stood on an entirely different footing from industrial wastes, and that probably it ought not to be considered in such a discussion as this.

The laws of New York State are drawn to distinguish between the two; very likely the laws of other States also; but if you think for a moment that even in the smallest town almost, there are little manufacturies here and there, that there is an occasional small mill or chemical shop, and that there is certainly a garage, or two, or three; these are places from which chemical wastes, acid wastes and oil wastes and other materials of that type are being poured into the city sewage system, into the canals, the sewers, and through these are reaching with the other material

the stream or water body into which the sewage is emptied. Now, take a large manufacturing city, and think for a moment how extensive those chemical wastes are that thus indirectly reach, with the sewage of the city, the stream with which we are immediately concerned.

The city of Troy, and I take that merely as an example, because you all know of its reputation as the great place of manufacture for collars and cuffs and shirts,—the city of Troy has enormous laundries. Washing fluids, coloring matter, chemical materials of powerful character are being discharged into the city sewage and are reaching the Hudson River through the sewers. They are no less significant than are the discharges from the paper mills located on the banks of the stream, that happen to be pouring a quantity of waste directly into the waters of the river, so that when we actually take up the analysis of the question it seems to me important that we should dismiss from our minds the somewhat artificial distinction between industrial wastes and domestic wastes, for that distinction no longer holds in practice, and the sewage wastes partake of the character of the chemical wastes and consequently, the kind of chemical being considered, produce the same sort of effect.

I hardly need to tell you that in recent times stream pollution has enormously increased. There are some features of the situation that all understand. The effect of waste is related rather directly to proportion between its amount and the flow of the stream, or the volume of the body of water which is disturbed. If you throw into Lake Erie a teacupful of prussic acid, which no one fails to recognize as a most violent poison, it might be difficult to detect the influence at once and surely a short time after the occurrence there would be no trace of the effect. Multiply the contamination by a hundred or a thousand and the effects become conspicuous. So it has been with stream pollution. When the land was young and the population scattered, anything could be done without serious results. Starting from that beginning, a small factory or a little mill on a stream, we have come to the point today where large mills and tremendous factories line the banks of the stream, and while the individual contribution seems to have but little effect, the total contribution is of very great influence. That has introduced into these situations an element

which must be kept in mind. At the start of our development the little factory was permitted to establish itself. It has acquired by virtue of that permission, a certain sort of a right. If at the present day we were to introduce a law, or enforce a law in such measure as to stop all industry, we should do ourselves, the cause we advocate, and the end for which we are striving with all our might, incalculable harm. I think that no fair-minded man really looks for a solution of the question which would endeavor to introduce and enforce on the moment a radical policy of suppression.

Having considered these general questions, let us pass for a moment to an examination of the situation as it exists, and I take care in this case not to go into it at all exhaustively, but to note a few facts that have come out of my work here in the State of New York. The same thing applies in large degree, if not throughout, to other states of the Union. The mere start on the problem opened up naturally some of the reports on file in the office of the Conservation Commissioner; and it was found that a considerable number of places had been reported because the results of stream pollution were so extreme as to force themselves upon the attention of state officials, and that here a small mill had been prosecuted and fined for pouring waste into a stream that wiped out all life of that stream and there an oil refinery had been handled in somewhat similar fashion. At another point a group of tanneries had been brought under pressure, had introduced a plan for the handling of the waste and had ameliorated the condition, if not entirely corrected it.

Following upon the discovery of these reports a questionnaire was sent out to every one of the game protectors in the state. Now the New York State Conservation Commission is fortunate in having a considerable force of these splendid employees devoting their time to a study of natural conditions. The game protectors received and replied to the questionnaire without any suggestion as to the reason for its being sent them. It was, in other words, to them one of the many inquiries that every official receives in the form of a questionnaire which he has to answer and return to the main office; and up to that time there had been no outside discussion of any special consideration of the problem of protection or of stream pollution in general. I

have here a summary of those questions and answers. It seems to me that they are very significant. We must keep in mind the fact that these are not men of technical training, either in chemistry, biology or in manufacturing. They are men of the woods; they are men accustomed to use their eyes, men of reasonable judgment in interpreting things they see, but not trained to deduce scientific conclusions from them, or to get precise and accurate measures of conditions. In the hundred replies it is very easy,—for there were just one hundred and one replies,—to see what the percentage was from the definite answers to the questions.

On the first question, asked if the individual had personal knowledge of specific instances where the discharge of wastes into streams was injurious to fish life, fifty-two of them gave an unqualified affirmative reply.

With regard to the second question, one-third of them, thirty-five, said that the effects varied from time to time. There were forty of them who were able to cite other persons able and willing to give further evidence of the existence of such specific pollution, injurious to fish life. I will not go into detail, but will mention only a few of the more significant cases. Twenty of them knew of instances and cited them where the property holders along the streams had suffered damage to live stock or property through the discharge of wastes into the waters, so that the effect was not confined to the effect in the water itself but extended even on to the land. Then there were seventy of them who said that they had not observed any change benefitting or injuring the fish after handling the waste, that is, after treatment of the wastes in various ways, but thirty of them had noticed specifically that the treatment of wastes at certain points had resulted in benefiting the fish life in the stream. Forty-nine of them, almost half, were positively of the opinion that the wastes from industrial plants in their observations affected the streams more seriously than the wastes in the city sewage; and in the classification of effects, thirteen of them cite milk plants in general, that is, canneries and factories and all the various plants that have to do with the handling of milk and its products. Eight cited oil and tar plants; thirty-five, works using acids; twenty-three, works using various chemicals; twelve, dye-stuffs; ten, tanning factories;

six, gas plants separately; nine, sulphite paper mills, and eleven, canneries. There were also some specific suggestions made by thirty of them with regard to methods by which the problem might be investigated or places at which it could profitably receive attention.

Under the advice of the Commissioner, I took occasion to visit a series of typical locations in the state, to see the effect of a group of manufacturers of the same type, and the localities selected included tanneries, sulphite paper mills and mills using or producing chemicals.

Now the natural objection to the demonstration of the existance of such wastes, and the seriousness of their effects, which was supported by a mass of testimony,—the natural objection to this is that it constitutes an unfortunate but a necessary and inevitable accompaniment of the development of manufacturing. But such a general argument as that is readily and perfectly met when we consider for a moment the conditions that prevail in other countries. When the manufacturer makes a statement to you or to any other person, and you ask him if manufacturing is as general, if population is as dense, in this country as it is in England or Belgium or France or Germany, taking conditions before the war, he will hardly venture to say that it is. We have in none of our states reached the development of manufacturing, we have in none of these states reached the density of population which exists in those countries. And yet fishing in the streams of the old world is better than it is in these streams in the manufacturing parts of the new world; and pollution at the present time is much greater here than it is there. Much improvement, as a matter of fact, has been made in the older parts of the world in the course of the last half century in cleaning up the streams, for they have paid attention to that, whereas of course we have rather neglected the problem.

In order to attack the difficulty properly it is necessary for us to consider the essential factors which are concerned in it. The situation is complex and not readily seen. If we go out to study conditions on the land, we see them with our own eyes. As we look at water its surface mirrors the beauty of the surroundings, but hides some of the conditions beneath, and it requires a very marked change in the character of the stream and the life

in it to bring about such conditions that they appeal to us, to our eyes, as departing from natural conditions, and as affording limitations or restrictions upon the development of aquatic life; but the essentials of existence under the water are the same as those which prevail on the land. A land animal requiring oxygen, must be able to breathe. It requires food. You shut it off from a supply of fresh oxygen, and it dies. You eliminate the food, and the animals are driven away or perish. Precisely the same conditions prevail under the surface of the water. If any factors reduce beyond a reasonable limit the supply of oxygen, the organisms that live in the water will be smothered. If any conditions drive away or destroy the food, the animals which depend upon that food will migrate or starve to death.

Let us apply this to the streams. It has been rather the fashion to test the effect of pollution on streams by looking for the fish, and if a fish was seen in the water, to say that that water was all right. It has been, in other words, the habit to rely upon a single criterion for judgment as to the quality of the environment. Most of you have seen areas here and there devastated by forest fires, and should anyone attempt to say to you that such an area was not damaged because he saw a deer run across it or a bird fly up and into it or out of it, you would smile at the crudity of such a suggestion. The same thing, however, applies perfectly well to fish. The fish are the largest and most powerful, and many of them are the freest in movement of all the water organisms. They course up and down streams. They make casual movements and migrations that cover considerable territory under varying conditions. They go about in search of food. When one area is crowded, pushing themselves off into other parts of the stream and seeking more favorable conditions for existence, they spread from point to point; and it is only rarely that one finds a stream in such a condition that the fish will not venture to enter into the water.

I can cite to you one instance which shows full well the significance of the argument that I am trying to bring before you at the present moment. The situation in Illinois is well known over the country in general. The city of Chicago has built a drainage canal which carries the city sewage down and into the Illinois and Mississippi rivers. The city of St. Louis at one time

carried out an action against the State of Illinois for polluting the waters on which St. Louis was dependent; and the conditions of the drainage canal, of the Illinois water and of all the water from Chicago down stream have been very carefully investigated. Now if you obsefve the river just below the point at which the drainage canal has emptied into it you will convince yourself very readily that it is nothing more in summer time at least, when the flow is reduced to nearly the lowest terms—it is nothing more than an open sewer, a septic tank in which the sewage has been deposited and in which changes are taking place to make over that organic material into a form such as can be utilized by the higher organisms. The little streams that run in are different in character. I have known of, and have seen, numerous instances where, watching such a little stream at the point of entering into the larger, one could see fish come down stream, swim up to what you would fix in your mind as the arbitrary line of division between the relatively pure waters of the small stream and the highly polluted waters of the main river; the carp would come to that line, stick their noses over it and go back again; come up again and do the same thing. They were possessed with a desire to migrate, but that desire was overcome by the conditions that they faced when they started to move from the smaller water into the larger. It is only very rarely one can see anything of that kind, because these larger fish often will pass into and through the highly polluted water in the endeavor to seek other regions where food is more abundant, or where for some other reason they desire to make their home.

Now then, the mere presence or movement of fish in any water is not necessarily indicative of the quality of that water. The second thing, of course, to which your attention must be called, is that different kinds of fish are very different in their susceptibility to impure water. From recently published experiments and tables it may be seen that the bullhead, for example, has a power of resistance or an indifference to polluted conditions which as compared to a minnow will be as forty-five to one,—so great is the difference between those two kinds of fish. Most of our valuable fish are rather sensitive to conditions of pollution, and do not find themselves happy or well situated in waters that are polluted to any extent, while some other fish can exist apparently without being incommoded.

But now as to a new test; the right measure of the condition of a piece of water is to be determined not by experimenting with that water on fish, but by observing the sum total of the living conditions in the water, and those living conditions may be determined by the examination and enumeration of the organisms that are to be found there.

Before I come to that, however, I want to say a word about one other thing. If you note these people who are arguing as to the harmless character of ordinary conditions in the streams, you will find that they very frequently say: "We know that fish are not very abundant there, and over-catching is the real reason for the diminution in the fish population of the individual stream." Now that sounds very true, and such a man will make a splendid argument as to the increase in the number of fishermen, the increase in the fondness for fishing and the increase in the means of getting about that has placed waters which formerly could hardly be reached in a week's vacation now almost within reach of a day's fishing trip. His conclusion is unassailable; the fish have been caught off. But, gentlemen, nobody has been catching the other organisms in the water; nobody has gone after insect larvae, or if they have been catching dobson or helgramites or something else for bait, they have not been catching the crustacea or the microscopic organisms of the water. If you take a pure stream and examine it under natural conditions, you will find it includes a rich and varied life; this is a fact with which you are perfectly familiar. There are green plants growing on stones; there are minute green plants floating in the water; there are little worms in the water; and other minute organisms of various kinds; if you take a net of bolting cloth you can collect a very considerable amount of that very stuff in all but in the most swiftly flowing streams. It is hardly necessary to state that that material which we speak of as plankton, constitutes the fundamental fish food of the water.

Now what about the food question? If the food is driven away from the water, if food is killed off, the fish will disappear; they will either be driven away or be starved out, and there is no possible alternative in the situation. Hence the simplest test in the world is to examine the waters so as to determine the existence of all those organisms that are characteristic of pure

free water. It gives an unanswerable argument, incontrovertible evidence in establishing the pollution of the stream; you have evidence not only that the existence of fish has been interfered with, but that if the fish were restored to the stream they would not find at the present time proper conditions for their existence there.

Now at various points in the country we are raising very considerable quantities of young fish. Those fish represent money. Each can of fry or fingerlings is a definite sum that the people of the state or the nation have put into this means for the replenishment of the water. And of what value is it, gentlemen, to pour fish into the stream where an examination of the conditions reveals the impossibility for the continued existence of such organisms.

I have hardly any need to remind you that it is the young fish which are of all most sensitive. All people have experimentally tried at times to make use of that sensitiveness as a measure of pollution. They have taken small or young fish and used them as tests of the purity of the stream. I want to try to show you the rather superficial character,—if you will permit me, with apologies, to designate it in that way,—of such a test by translating it into human terms, for this question is exactly the same problem that has concerned medical men and sanitary experts in seeking to control the condition of the air in manufacturing plants. Suppose a manufacturing plant were cited by a sanitary official for polluting the atmosphere and endangering the health of the workmen, and the expert should take a dozen children and divide them into two groups; six of them permitted to play in the air outside; and six were set on the floor of the manufacturing establishment for three hours or five hours. If they died the conditions were to be declared such as to demonstrate pollution of the atmosphere, and I do not suppose anyone would doubt that; but, gentlemen, the conditions with which we really have to deal are never so extreme as that. I would challenge you to cite a case of atmospheric pollution that would kill off even sensitive children within three or four hours. And yet that is what the same people expect the minnow test to do, to decide between what is right and not right. Of course if the minnows are killed, conditions are bad enough to demand instan-

taneous action on the part of somebody, but if they are not killed off, the situation has by no means been analyzed to the extent that is demanded. We must find out not merely whether short exposure to those adverse conditions is going to affect the fish unfavorably, but whether the conditions in the water have been so modified that the chance of the fish obtaining food, the chance of spawning and propagating itself, have been seriously interfered with.

And that brings us to a point where we should consider for a moment the different ways in which pollution affects fish life. I will pass over these very rapidly. Perhaps I should say the different ways in which fish affect the human species, for, after all, that is the fundamental point in our discussion and I need not say anything to you about the esthetic side of the question, fond as I know some of you to be of outdoor life. It will be suggested to you at once, that the people possess in our streams and ponds an asset for enjoyment that is of great value, and that should be preserved reasonably in its natural condition. I need not say anything to you as to the value of streams for the use of communities for bathing. No boy who is born, as I was, on the banks of the Hudson, brought up at a time when stream pollution had not reached its present condition, could fail to appreciate the value of going swimming. But some spots where I used to go swimming in the Hudson are to-day in such condition that anyone might well hesitate before he plunged into the water.

I want to speak definitely of the points at which we have suffered distinct financial loss. The pollution of our streams in the first place has been of definite financial damage to the landholder. He is unable to use the water for watering stock. He finds his cattle are poisoned in extreme instances, or do not thrive. He finds that his rights are interfered with, and of course that constitutes a legal right of action which to be sure is not often availed of because of the well known uncertainties of the law and of the difficulties which the individual meets in enforcing his rights against the larger and more influential body.

Then of course the greatest loss to the people is the loss in fish. Now I think pollution affects the adult fish, but it affects still more the young and the spawning grounds. Over the spawning grounds in a polluted stream is spread a mass of filth that

decays slowly. Those areas are not in condition to permit of spawning and proper development of the eggs. You would not expect that if you allowed such materials to fall down even in small quantities over the eggs in hatchery troughs you would make anything like a good report of your hatching operations. The young fish are very sensitive to these conditions, and I do not doubt that the reduction in the shad output of the Hudson River has been most radically affected at these two points in the life of the fish through the destruction of the spawning grounds, that is by the covering of the spawning grounds with decaying material, and through the pollution of the waters to such an extent that the young fish can not find proper conditions for existence.

I hardly need to mention that such conditions are slow in finding a recovery. A stream which has been visited with an acid bath, or scoured with a strong alkali, one in which all the life has been wiped out by a poison, such as prussic acid, takes many months, if not years, for its recovery, and it behooves us to establish such conditions that the initial destruction of life cannot take place.

A famous biologist who has studied carefully the waters of western Pennsylvania says that those streams where washings of coal have passed down them, are real deserts, barren of all kinds of life, and is inclined to the view that it will take centuries for their repopulation, if indeed ever it is possible to re-establish even approximately the conditions that existed there before.

Now it is a very conservative statement of the case to say that this destruction of natural resources does not fall under any reasonable construction, within the rights of the individual. I recall the time when people were accustomed to dump their garbage into vacant lots or back alleys, if not sometimes into front streets,—and I am not very old. Those conditions have been removed in certain parts of the country within relatively recent times, and I believe I am not far from right in saying that it might be possible to find places where such conditions prevail even at the present time. Those are precisely the conditions that exist in our waters. I have seen myself, as probably all of you have also and that within relatively recent times, on the passenger boats passing up and down our great rivers or along

the waters of one of the great lakes, cases where men brought great buckets of garbage to the edge of the boat and threw the stuff into the lake or the river, and where broken up boxes, together with the rinds of canteloupes or oranges were tossed overboard. I have seen places where that stuff floated to the shore. That is gross pollution of the water, and that sort of material lasts for some time. It is obnoxious to the eye. It offends us. But it is not stopped. Why? Because there seems to be in the minds of many people the idea that the waters are a sort of waste-basket, a garbage box, a dumping field, into which all kinds of waste can be thrown to get rid of it at any time.

Let us take a more serious thing. A tanker has come in from the ocean and entered one of our bays near here. Before reloading they have washed out the ship and have discharged into the water of the bay thousands of gallons of oil. I think that is not an exaggeration for the discharge is very large—they pump the mixed salt water and heavy oil refuse into the bay. It floats around on the surface in a scum so thick that if you push a row boat through it a line of the oil adheres as a distinct band to the side of the boat. It is not necessary to show in detail the certain effect on the aquatic life of that region. Surface organisms which form the food of many fish are totally destroyed and shore life suffers greatly also when the refuse is washed up on the beach.

All these things merely illustrate the indifference or ignorance of people generally with reference to the value of our water areas. In my opinion, the first thing needed in correcting the situation is a campaign of education. I do not believe that you will ever get the question of pollution settled until it is possible to teach the average man that these things are wrong, until the average man resents them in the same way you and I would resent our neighbors pitching garbage into the alley behind our homes or into the street in front of them. When public sentiment demands the correction of the situation, then it will be possible adequately to enforce the law.

But education must not concern itself merely with this phase of the problem which affects the people as a whole. Education must concern itself also with the individual responsibility for the wastes, with the manufacturer, with the person in control of

business interests, with the men at the head of affairs. Business is naturally conservative. It does not desire to move even if the movement is said to be advantageous, when the proposal has not been tried out by somebody else through a long enough period to establish the certainty that it will pay; and proper action will not be taken by manufacturers and by those who are responsible for the pollution until they are brought under the pressure of conscience and education as well as of law, until they have seen the public disadvantage and have learned something of the private advantage in handling the wastes instead of discharging them thoughtlessly into public waters.

Now the utilization of wastes is a rather complicated question. Most of you recall the way in which industrial commissions are forced to bring pressure on manufacturers to install safety devices. I think the majority of manufacturers, especially at the present time, will confess that it has been to their advantage to introduce such safeguards for labor, but it has required the force of a very powerful campaign with the public and in the halls of our legislatures to pass such legislation and to compel the introduction of protective devices in factories. The same thing is true right here. A concrete instance can be taken from New York State. The Standard Oil Company at Olean has a refinery which had discharged enough wastes at previous times to destroy all life in the stream into which they were emptied. Under the influence of the conservation law and of the pressure exerted for the enforcement of the law, they introduced a special plant for the refining and utilization of these waters. As a matter of fact that plant not only corrects the evil and protects the people, but it really yields to the company a good return on the investment. In other words, they were forced to undertake something which has proved to be for their financial advantage; but I doubt if there or elsewhere the same results would have been brought about unless it had been for the pressure exerted on them from the side of the people and of the Conservation Commission.

I shall pass over some other phases of the problem of education and speak for a moment of the need of investigation. These questions involve, of course, many very complicated problems. I have called your attention to the difficulties of deciding them in ways in which the problems of the past have been decided. I

do not believe it possible for the chemist to experiment with fish alone through a brief period, and establish the harmlessness of wastes. I think there has been an abundant amount of scientific investigation to show that many wastes are harmful in the worst possible sort of way, tho on short experimentation these substances seem to exercise no particular influence over the fish. To show you how insignificant, how very small an amount of a chemical may be when it operates at a long distance, let me cite to you a specific instance. The city of Lincoln, Nebraska, uses water for drinking purposes from deep wells. At one time there was typhoid fever in the city. It was suggested that in some way these wells had become contaminated, and the city started at once treating the water with chlorine in very small amounts. We had in the zoological laboratory a big aquarium room in which were kept a lot of cultures of microscopic organisms. That room was supplied with city water. It was at a distance of several miles from the point where the water was treated. We were unable by tests to determine the presence of chlorine in the water and yet these microscopic organisms promptly died off, and it was impossible to reestablish the cultures; they would not live in that water.

Now the food of the fish consists of or is dependent on those organisms. The small fish might eat them themselves. Larger fish would eat an intermediate sized organism that ate this smaller type. The destruction of that food would drive away any fish just as directly as if the fish themselves had been affected by it; and I am not here to contend that the fish are not affected by it, although the degree of influence on the fish was so small that it could not be told by the type of experimentation which has ordinarily been tried.

In the next place I want to call your attention to the fact of changes which are making very serious modifications of natural conditions, changes that are well-illustrated in New York state and also at many other points. We are beginning to make over natural water systems into a series of ponds. When we put up dams, in what was formerly a rippling stream coming down over the rocks, absorbing large quantities of oxygen, and undergoing changes that tend to purify it and put it in splendid condition, there is substituted for it a deep pond almost without movement

of the water; the stream is being utilized for power. The result of that can be seen very clearly when one examines such a place as the upper Hudson. The sulphide wastes from a mill at the upper end of the series of sulphide mills have accumulated in a basin behind a big power dam until this upper lake has a bottom covered with polluted material and without the evidences of life characteristic of clean and unpolluted water. Where the water comes over the dam—or through the wheels, as it mostly does—it shows evidence very clearly of its polluted character as it starts down over a long series of riffles below the dam. You can see in the lack of the organisms characteristic of free water and in the presence of organisms characterizing polluted water, that there is pollution in the water near the dam; if you follow the current down over the riffles the organisms of pollution gradually disappear, the organisms that are in free water gradually appear until you come to the next relatively still waters, of Big Bay as it is called, above Glens Falls, where you get a rich growth of green plants and all other conditions that indicate pure water. In that stretch of the river there is splendid fishing. It is in passing Glens Falls, Hudson Falls and Fort Edward, with their numerous sulphide mills, that the water accumulates its pollution again, and below Fort Edward it has just the character that was manifested in the polluted basin higher up, only in more conspicuous and extreme fashion. These conditions suggest to us what will happen when another dam is built, and one is projected near the foot of the riffles at the head of Big Bay. It will transform the riffles above the site of that dam into a pond. Within that pond the slower movement and the limited contact of the water with the atmosphere will prevent the acquisition of oxygen, will prevent correcting the conditions of pollution, and will transform that stretch of the river also into a polluted basin. And so the building of a series of dams may readily make over a stream from one which is able to purify itself, despite the waste added to it, into one in which such conditions for purification will not exist. It behooves us then to consider the pollution question not merely on the basis of present conditions, but on the basis of probable changes which will accentuate those conditions that are unfavorable.

Important as the question of pollution is from the standpoint of food for the war, we must not forget that its significance reaches much further into the future. Food will probably never be as cheap in the future as it has been in the past. If we are to have in this country those conditions of existence affording a varied food supply of an abundant type which has given the physical vigor, intellectual strength and independence that we as Americans are proud of, we must see to it that all possible means are taken to increase the food supply, to check these limitations on it, to improve the conditions that surround its production. We have in stream pollution, in my opinion, one of the most important of these factors. We have means of testing it definitely, and beyond question when those means are applied by a careful study of the situation and when the conditions that these tests reveal are made known to the people at large through campaigns of education. When the situation is brought home to men in positions of leadership, responsible for establishing these conditions, the pollution will be eliminated and the streams restored to something like their original purity. But, gentlemen, without the cooperation involved in that outline of conditions we shall not be able to correct the situation. So sure as we start upon the reform of these conditions with violence, with suddenness, or regardless of great industries that are essential for the prosperity of the country, just so soon shall we involve ourselves in discussion and contention in which, without public support, our cause will be lost.

DISCUSSION.

Mr. N. R. Buller, of Pennsylvania. Mr. President, the commonwealth which I represent has more pollution within its boundaries than any other state in the Union, on account of its vast mining interests and its industrial conditions. We have at present approximately 60,000 mines and industrial establishments within our borders. Only a few years ago, during the term of my predecessor, the first efforts to stop pollution were made. I believe with Dr. Ward, after the experiments that have been made, that the only true remedy is cooperation and education. Bringing prosecutions and imposing fines does not remedy the conditions.

Pennsylvania has made vigorous efforts to correct these evils. The functions are divided, the Department of Health having jurisdiction in so far as sewage of cities is concerned and the Department of Fisheries over industrial conditions and mines. I am of the opinion that this is wrong and that it should be under one head having authority over both sewage and industrial questions.

Pollution in Pennsylvania is at present increasing, due to the great activities of the war, and the Department of Fisheries is flooded with protests from all sections of the state concerning the destruction of fishes. The great munition plants have so increased their activities and capacity that on the west branch of the Susquehanna River from Emporium to Sunbury, a distance of about ninety miles, the discharge of the past six months has killed every living thing in the river, where heretofore there was reported good fishing. The Attorney General of the Commonwealth has advised that under present conditions no prosecutions shall be brought, but that investigations be made and data furnished the War Industries Board at Washington. This board has indicated to our Fisheries Department that they are investigating and that if it is possible to avoid this pollution it will be stopped.

Mr. Carlos Avery, of Minnesota. Dr. Ward has sounded the key note in saying that a campiagn of education is first absolutely necessary. We naturally apply what he says to our own localities and conditions. The Upper Mississippi has been for years and is yet one of the most famous breeding grounds for many varieties of food fishes. At the Twin Cities we have a population now approaching a million people using the Mississippi River as a sewer, and nobody has ever thought of anything different. All the way down the river we find the smaller cities doing the same thing. Now if that is going to result in the extermination, or in a serious depletion, of the fish life of the Mississippi River, we ought to begin to consider that problem. In connection with the educational program that Dr. Ward has suggested, it seems to me that we ought to go farther and be prepared with some suggestions as to remedies. I would like to ask him whether he could in the case of Minneapolis and St. Paul, suggest anything that would, in a measure, dispose of the sewage of those cities without polluting the Mississippi River.

Fishermen have told me that they have found solid wastes from the packing plants of South St. Paul forty and fifty miles below that point, grease, hair and other wastes that could be positively identified as coming that long distance, showing that it must affect the river for many miles. If Dr. Ward could supplement what he has already said by some suggestions along this line it would be very helpful to us in our locality.

Mr. M. L. Alexander, of Louisiana. The manner in which Dr. Ward has analyzed this situation has given us an entirely different view point on the question. We have been impressed too much in the past with the value of the industry located on the stream. We have lost sight of the fact that the streams and the life of the streams belong to the whole people, and therefore should be protected. I am thoroughly convinced of the fact, however, that it is going to take a campaign of education to bring about the desired results. I believe that this Society could not take up any greater work than this of educating the people throughout the United States to the necessity of eliminating stream pollution and of devising ways and means by which factories and other great industries located along the streams

throughout the United States may take care of their wastes. Some means must be adopted to remedy the condition and therefore this Society could well adopt as its slogan, "the reduction of stream pollution." I hope that this paper of Dr. Ward's will be published and spread broadcast throughout all the states of the Union.

Mr. George D. Pratt, of New York. This difficulty looks like an insurmountable one. All of the rivers of all of the states are being polluted. There is no question about it. In New York we have a law which prohibits the putting of pollution in streams where it is destructive to fish life. I do not agree with Mr. Buller that fines and penalties do not have a helpful effect. In New York they are very helpful and in our experience we have found that people who are fined for pollution immediately make an endeavor to improve the condition. Last week some of the people who had been polluting the streams, with representatives from Cornell University and the Commission met in Albany and went over this whole matter to see what we could do to form a policy.

One question that Dr. Ward brought up concerns the throwing of refuse from steamers. It would be a very simple matter to pass a law absolutely prohibiting steamers from throwing refuse into the water. They can consume it just as well as not in their furnaces.

In the case of pollution by manufacturers, we are trying to get the manufacturers in and to confer with them. There is a feeling on their part that they do not want to give away any of their secrets, but by a cooperative spirit on their part and on that of the Commission we may get them to tell each other how they can prevent pollution.

Now pollution can be prevented, and in New York we propose to go at it. It is not a question of doing it in a day. I believe if we all had laws passed as was done with the railroads in regard to air brakes, etc., and give these people five years to get rid of their pollution, and after that time, go after them hard, that it can be done. If we all work together on this problem we can clean up the situation. This organization can do no better work than to attack this pollution problem.

Mr. Wm. C. Adams, of Massachusetts. We are carrying on an interesting experiment in Massachusetts. It is a very large question, the extent to which pollution will keep fish out of a stream when they run up in the spring to spawn. We have in our state a vast water system, the Taunton River and its tributaries. For a number of years some of the fish ways on this river have fallen into decay. This last year The Connecticut Mills Company rebuilt, at its own expense, the fish way around its dam, which is the first obstruction to the run of the fish on the Taunton River. We have drawn the plans and provided the specifications for the installation of fish ways at all of the necessary points on that entire system.

It is argued that the fish have disappeared from this stream largely from two causes: first, the disappearance of fish ways and second, the presence of pollution in the streams. As far as the effect of pollution is concerned, it appears to be a mooted question throughout the entire United

States as to the extent to which it actually affects the fish upon the flood waters in the spring. We know that if there were no fish ways it would be impossible for a fish to get up. If the fish ways are there, and then they do not go up, it is certain that you can charge it to pollution, especially if the necessary steps are taken to see that the rivers are stocked in their upper reaches.

We have a very drastic pollution law in Massachusetts giving our commission very autocratic powers. We have been just as reluctant to invoke these laws in certain directions as has been intimated by Professor Ward. On the other hand, we do find there are two ways of getting at the thing. There is a certain class of corporations that are just wise enough to the political strategy of the times that they do not want to oppose public sentiment any more than they can help. A large number of these corporations will exploit a state asset in the shape of water power, but they do not want the thing uncovered. We find that class of corporations perfectly willing to cooperate with us whenever we, within reason, will point the way. There is another class of bad actors that will compel you to put the short rope on them before they will do anything.

In this pollution question it occurs to me that the commissions have a two-fold duty. It is a biological proposition and an engineering proposition. If we had in each one of our state commissions an engineering expert whom we could send into the X. Y. Z. Company and say, "Gentlemen, I come here from the State. Any communication that you make to me will be considered as a privileged communication. Our desire is to work with you in removing pollution. If you will reveal to us the character of your pollution and show us exactly how you handle it mechanically, we will undertake a constructive study to see what we can do in suggesting to you a plan by which you can eliminate it. The state will stand the expense in the first instance, because we regard this very largely as a state duty in clearing up public waters, and then we will map out and give to you our plan of constructive development." That will enable us to carry on our campaign of education with these men in the most subtle and indirect manner, because a practical business man at the head of one of these companies will look at consequences and results and he will be ready to help you all he can.

Mr. George D. Pratt, of New York. Concerning the matter that Mr. Adams speaks of, in the conference we had last week these men said, "You tell us what to do." I said, "No, I will not, that's up to you." I told them it would take a force of men as large as the number we have on the Commission, over five hundred, to take care of all the different plants in the state. Take the pollution from tanneries; it is an entirely different question from the pollution from milk products, and pollution from lumbering is another proposition. They are all different. Now, they all have their own chemists, and it's for them absolutely to work it out. If we allow them to put that up to us, they are going to "pass the buck" every time. The way to work this problem out is to make them do it, and they will do it if they are made to.

Mr. W. H. Killian, of Maryland. It has been only a comparatively short while since I have been concerned with fish conservation and propagation, and in that short time it has dawned on my mind that the biggest problem we have is this very problem under discussion, and I feel very well repaid, so far as our work is concerned, if we do not have any other subject under discussion at this meeting. It has been dealt with by the states individually for a longer or a shorter period according to the activities of the state administrations charged with the matter, but it seems to me that very recently many of these big problems have become national problems.

The Food Administration has been accorded very autocratic powers of late, and the fact that this pollution is not only affecting the food production at the present time, but is going to be cumulative and far reaching, it appears to me should lead this Society to take some action to interest the Federal Government in the matter.

We are concerned with just the same proposition in Maryland that the several commissioners who have preceded me have spoken of. We have very drastic laws and made some progress in putting them into effect, until the Federal Government's own activities within our area, within the past twelve or fifteen months, have rendered the Government itself one of the greatest violators of our local laws. We find that when we approach them we have to deal with department heads assigned to the individual operations, who frankly tell us, "I get my instructions from Washington." Then we are "stumped," just as Mr. Buller stated in the case in Pennsylvania, where his legal department advises that no interference should be imposed. It has so seriously bothered us that we have felt under the necessity of taking it up with the Secretary of War, with the hope that if we could impress him with the proposition, some general policy might be laid down by him whereby the individuals dealing with the separate operations would at least be instructed to cooperate with the state officers where a conflicting problem arose.

If food is such a vital necessity in the conduct of the war as to make it necessary to establish a new branch of the government for handling it, it would seem to me that perhaps we should get a great deal of help if we could interest the U. S. Food Administration in this matter. Or, if we could address that appeal to the War Department, or any other department of the Federal Government that has activities that are adding to this problem that is troubling the various states, it would be the proper thing for this Society at this meeting to present the matter, and I hope that the resolutions committee will, before we adjourn, take some action in that connection.

Mr. W. E. Barber, of Wisconsin. I thoroughly agree with Commissioner Pratt of New York. I believe that these manufacturing institutions owe something to the people of the states in which they are operated. The only way to settle this question, in my judgment, is to have a good, stringent law with a heavy penalty, and let the chemists of those organizations work out the problem. We have had so much experience with the plants in our

state that we are thoroughly convinced the only way to get action is through a stringent law with heavy penalties.

We surveyed the plants of our state, and sent out letters to each one telling of the conditions and reciting the law on what was expected of them and what they must do. Some of the mills responded that they would investigate and see what could be done. One plant in particular, responded that they would refer the matter to their attorneys, and see what was necessary to be done. That's the sort of cooperation you will get on the part of some of them. We must insist upon our legislature passing laws that will make these men take care of the situation in each individual plant. It is preposterous to think that a state conservation commission or a board of health can spend its time or the state's money to survey each of these plants and then watch each individual to see that he obeys the law. These plants have men that can work out a system of disposing of waste in a way that will not pollute the streams.

In our state the chemical engineer from the State University, who is working with the State Board of Health, has looked over these plants, and made plans and blue-prints of a system for taking care of these industrial wastes and presented them to some of the firms. The law should compel those men to take care of their own business just the same as the manufacturers of the state that are not interfering with the public welfare take care of theirs.

Prof. J. G. Needham, of Cornell University. Concerning the discrepancy of views between Mr. Pratt and Mr. Adams. I think they are both right. It is entirely feasible, when information is available and a method is well known whereby pollution can be eliminated, for a commission to help a factory towards getting rid of it. But suppose it is an unsolved problem,—and most of the problems of pollution are still largely unsolved—it behooves us to compel factories to put a chemical expert on the job, for the chemical expert is trained for the productive side. In almost every case, he is not trained for such matters as are involved in the disposal of the waste.

There is a mode available to manufacturers, that is becoming more or less widely used, one end of which we see at the University in the industrial fellowship courses. A good many industries are appointing men to come to us for the necessary training for work in their institutions and factories, bearing directly on problems that have arisen in their factories. These men get the benefit of the conference of views, bringing to the problem all sorts of knowledge available in the University, and work towards finding a solution of the difficulty. That is industrial fellowship, a name borrowed from classic literature. They are simply investigators hired at first by the firms that need them. These industrial fellowships have resulted already in solving many problems of pollution, and of getting rid of wastes by turning them into something useful.

It has so come about in many cases that large interests have been involved, and that where a few people have supported a thing of this kind

for a year or two, the state has now taken it up and has furnished funds to continue the work. You may know of the fund that was provided by New York last year for the investigation of bean diseases. A few bean growers had worked on the problem for two or three years, and finding so many were affected and the prospect for results was so good, they took it to the legislature and got a foundation established to keep the work going. There is no reason why any group of industries with large problems of pollution on their hands should not avail themselves of outside help in this way, in case the men on their staff are not equipped for the study of those problems.

I have a friend here in the city who got up a course in the chemistry of paper making in the University of Maine a few years ago, a four years' course with all of the aspects of paper making treated which did not have anything in it about the disposal of the wastes from the paper mills to make them innocuous to the life of the streams.

Coming from an educational institution, I am greatly pleased to hear the educational aspects of this matter emphasized today, and I want to say that besides research, which is, of course, our large function, is a good deal of assistance that perhaps we can lend in this very thing. We have at Cornell one of the most complete arrangements for utilizing the enthusiasm of the youngsters in the schools that can be found anywhere. The school leaflets that are issued there cover all sorts of subjects of interest to children in the schools. There is no reason why we should not devote an early one of these to clean water and I will go back with the suggestions made here today and see that we do it at once. If we get the youngsters interested in keeping the streams clean, so they can fish and swim and have places of rest and recreation and where the beauties of nature can be enjoyed, we have gone a long way toward the solution of our problems. We love to call this country of ours "God's country," but it is not God's country any longer when it gets to be a place where you have to hold your nose.

RESULTS OF SOME TROUT FEEDING EXPERIMENTS CARRIED ON IN THE EXPERIMENTAL HATCHING STATION OF CORNELL UNIVERSITY.*

By G. C. Embody,
Assistant Professor of Aquiculture.

The rise in cost of the fresh meats commonly used in feeding trout has made it necessary to find something which might be substituted partly or wholly therefor. This was the chief purpose in initiating the experiments referred to in the present paper.

A trout food in general should meet two principal requirements: first, it should keep the trout in perfect health, rendering them less susceptible to the attacks of various diseases, and second, it should be efficient as a flesh or egg producer. That is, it should produce flesh of prime quality in the shortest time and with the least expense, or in the case of eggs, their quality, quantity and cost should constitute the essential consideration.

One must recognize, of course, that the food is not the only factor to be reckoned with in the production of fish flesh and fish eggs. Undoubtedly fish are much like poultry in that the ability of certain individuals to grow rapidly and produce eggs in quantity, is inherited and not acquired by the use of certain foods. Some individual trout may not grow rapidly nor produce eggs in quantity even if given the best known foods in abundance. Nevertheless fish cannot grow nor produce eggs of normal quality and quantity without proper food. Inasmuch as liver has been the most generally used food in trout hatcheries, it was thought desirable to compare any new foods with liver as regards the two principal requirements, health of the trout and efficiency of the food.

Several wooden troughs identical in size were set up in such a manner as to receive exactly the same volume of water per minute from the same source. Each trough was provided with a

* This paper was awarded first place by the American Fisheries Society for original work in fish culture.

cover which could be locked securely. The water always contained oxygen to the point of saturation. It was also rendered free from all food organisms by passing it through a settling basin and series of screens. Thus the conditions in each trough were identical with those of every other trough insofar as it was possible to make them.

Preliminary tests indicated that the most accurate measurements and observations could be taken only in comparatively small basins and with a small number of trout. Consequently, the troughs just described were made to hold a volume of water available to the fish, 3 feet long, 16 inches wide and 5 inches deep and the number of trout placed in each trough varied from 46 to 100 depending upon their size. A regular hatching trough 8 feet long and 14 inches wide was used for the chinook salmon fingerlings, while in the case of 2-year-old brook trout, a cement basin 8 feet long, 3 feet wide and 14 inches deep was found convenient.

All the trout were weighed in a glass vessel of water which had previously been balanced upon a set of standard laboratory scales. The trout were first taken out of the trough with a small dip net, allowed to drain one minute and then carefully placed in the glass vessel of water. The net was then lifted carefully out of vessel allowed to drain one minute into the same, and then the process was repeated until a sufficient number of trout were ready to be weighed. With this precaution the error due to adding or removing water was reduced to a minimum. Weights were always taken from 12 to 15 hours after feeding.

The experimental procedure consisted in (1) weighing trout at the beginning and end of each experiment; (2) feeding them once daily in the case of yearlings and twice daily in the case of fingerlings. The food was given slowly and in sufficient quantities only to insure entire consumption. Hence there was no waste to be deducted from the total weights as recorded. (3) Records were kept of the total food consumed during the experimental period; of the mean daily water temperature, and the mortality. In this manner a rather large series of data was obtained, the more significant of which are included in a table which follows.

FOODS USED.

Aside from beef and pig liver, the former used for comparison with other foods, the following products were tried:

Meat meal, known also as "animal meal" and "fish meal," is made entirely from scrap lean meat, dried and ground. It is put out in three grades—fine, medium and coarse—and retails for about 5 cents a pound in 100-lb. bags. It contains only a minimum amount of fat, is practically free from dirt and will keep indefinitely in a dry place. Meat meal is valued principally for its high protein content.

The fish meal used was manufactured from marine fish of species not placed on the market. It contained only about 10% fat and was kept for two years without deteriorating. The cost was approximately 4½ cents per pound.

Shrimp meal, commonly called "shrimp dust" or "shrimp bran," is the refuse from the Mississippi driers and canneries. It consists of the dried parts of shrimp and prawns not used for human food. It varies in texture from fine meal to coarse irregular pieces and will keep indefinitely in a dry condition. Although slightly deficient in available protein it contains a large amount of chitin, a substance that trout secure abundantly from many natural food organisms, in addition a large per cent of common salt, phosphates and lime. The cost is approximately 2½ cents per pound.

Peanut oil meal is the refuse from various manufactured peanut products. It is valuable alone for its high protein content. The retail price is about 2 cents per pound.

Red dog flour and wheat middlings are well known to fish culturists. It is only necessary to recall that the price of the former has advanced to about 3½ cents a pound and that of the latter to 3 cents. Both of these products have but little value as food for trout, but they were useful in experiments for the purpose of binding together the dried foods.

FOOD MIXTURES AND THEIR PREPARATION.

All fresh meats used in the experiments were prepared in the usual manner by grinding to the necessary degree of fineness for trout of various ages.

The following mixtures of the products mentioned above were tried:

I.

Beef liver	60%
Red dog flour	40%

II.

Beef liver	45%
Meat meal	45%
Flour	10%

III.

Beef liver	50%
Fish Meal	50%

IV.

Meat meal	35%
Fish Meal	35%
Flour	30%

V.

Meat meal	50%
Shrimp meal	30%
Flour	20%

VI.

Meat meal	40%
Shrimp meal	40%
Flour	20%

VII.

Meat meal	45%
Peanut Meal	45%
Middlings	10%

VIII.

Meat meal	85%
Liver and kidney	15%

In mixtures I, II and III, the flour and the various meals were merely stirred into the ground liver and fed directly. In IV, V, VI and VII, the various foods were first mixed dry in the proportion indicated; then boiling water was stirred in until a thin mush was obtained. This was allowed to cool, broken up into small pieces and thrown to the fish. In the case of mixture VII, the meat meal was made into a mush in the manner just described and fed six days each week. On the seventh day a mixture of equal parts of liver and kidney were fed alone in the usual manner. This actually amounted to the proportions indicated even though the meal and fresh meat were not mixed when fed. In feeding meat meal alone to advanced fry and small fingerlings, the meal was sifted to eliminate coarser particles and the fine siftings were merely sprinkled over the surface of the water in a dry condition.

The numerical results of these experiments are condensed in the following tables. The figures to be noted chiefly are those expressing the efficiency of the food, the cost of food necessary to produce one pound of fish, and the mortality.

The efficiency factors are used to express the relation between the gain in weight of trout and the amount of food consumed. The direct factor is found by dividing the weight of food consumed during the experiment period, by the gain in weight of the fish for the same period. It merely states directly how many

pounds of food were required to produce one pound of fish. The reciprocal factor is found by dividing the gain in weight of fish by the weight of food consumed and expresses the fraction of a pound of fish produced by one pound of food. The direct factor is very convenient for calculating the cost of the food used in producing a pound of fish. It is only necessary to multiply this factor by the cost of the food per pound. Thus, in the first table, in the case of beef liver, the average direct factor for a period of 70 days was found to be 3.16. Multiplying this by .12, the cost of beef liver per pound, we find that the cost of producing a pound of fish was $.379. It will be seen that the higher the direct factor the greater will be the cost of the fish. In the case of the reciprocal factor, the higher the factor, the lower will be the cost of the fish.

The mortality as recorded in the table represents the number of deaths occurring each week in per cent of the total number of fish used in the experiment.

Comparing the various food costs for producing a pound of fish, it may be seen that the highest costs occur when liver is used alone or in combination with flour—series A, B and C. As the amount of beef liver is lowered so is the cost of production lowered. Except in the case of chinook salmon, where the food mixture contained only 15 per cent liver, we find the four lowest costs to have been obtained with mixtures containing no liver—series F, G, H and I. In not one of these four series, however, was the experiment period longer than 36 days and hence further trials may change the figures to some extent. This is particularly true in the case of the meat meal-fish meal-flour mixture. Nevertheless the average of costs in the four cases—10c—is low enough to indicate clearly the high food value of these dried meals. Outside of series F, where the production cost of 6 cents is undoubtedly too low, the most economical mixtures seem to be those containing meat meal and shrimp meal with a small amount of flour for binding the mass. This is indicated in the two series, G and I, where the production costs are about eleven and one-half cents in the former and a little under eleven in the latter.

The trials with the meat meal-peanut meal-middlings mixture, series H, were so high that it was thought best to test peanut meal alone. The same fish used in series H were fed a mixture of

Peanut Meal.....90%
Middlings.....10%

This was made into a mush and fed in the usual manner. After 15 days of this ration, the trout lost 8.9% of their weight and were subsequently attacked by fungus which killed about 50% of the fish before it could be checked.

This is a rather striking indication that the protein in peanut meal is practically indigestible in the case of trout and since it served no useful purpose, it was thought best to dispense with it altogether.

MORTALITY.

The true state of affairs regarding mortality is not indicated clearly by the tabulated figures except possibly in the case of mixtures containing a large per cent of beef liver. During the past three years of experimentation, it can be said that no abnormal death rate has ever occurred when beef liver was used in mixtures to the extent of 45% except where the loss could be directly attributed to causes other than the food. This cannot be said of mixtures containing the dried products alone. Continuous feeding of these in nearly all cases eventually resulted in a high mortality. The period before the mortality began varied from one to three months depending upon the age and species. In general fingerlings were more susceptible than yearlings and older trout, and rainbow trout were less resistant than brook and brown trout. In nearly all cases this high mortality could be checked in the course of two weeks by changing to a diet of some fresh meat. Liver, lean meat, kidney or melts were all equally effective in bringing about the change. This discovery has led directly to our recent practice of feeding one ration each week consisting of some fresh meat alone and on the other six days using various mixtures of meat meal, shrimp or fish meal, together with a small amount of middlings as a binder.

During the present year, only, have we been successful in using any of these dried foods for rearing advanced fry to fingerlings. In the case of some chinook salmon, ground liver and kidney was fed twice daily in alternation with three daily feedings of meat meal. The latter was first sifted to remove the coarse particles and then merely sprinkled over the surface of the water. The salmon took this readily from the surface and usually cleaned up that which sunk to the bottom. The total mortality from the

time feeding began until the salmon averaged two inches in length was about 20%. Since that time the amount of liver and kidney has been reduced to one ration a week, the other daily rations consisting of meat meal alone. The results with this food are shown in Series J, of the table.

CONCLUSION.

These experiments must not be considered as finally disposing of questions concerning the use of these foods for trout. They are rather preliminary to a much larger series contemplated. Therefore, it is perhaps wise not to draw too narrow conclusions at this time. However, it seems not unreasonable to believe that the cost of rearing brook trout may be materially lowered by the partial substitution, at least, of some of the dried meals mentioned, for certain of the high priced fresh meats now in use.

ACKNOWLEDGMENTS.

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TABLE OF DATA ON FEEDING EXPERIMENTS UNDERTAKEN AT CORNELL UNIVERSITY, 1915–1918.

Food Used and Cost Lb.	Age of Fish in Months	No. of Fish	Exp. Period in Days	Av. Daily Consumption in Terms of Perct. of Wt. of Fish	Efficiency Factor		Cost of Food to Produce 1 Lb. of of Fish	Ave. Mort. % Weekly	Ave. Daily Water Temp. C.	Series
					Direct	Reciprocal				
Brook Trout.										
Beef liver $ .12	16	46	14	4.65	3.89	.257	.....	.....	12	A
	16	46	14	4.69	3.1	.3137	.....	.....	13.5	
	17	46	14	3.8	3.4	.287	.....	.....	15.5	
	18	46	14	4.2	2.89	.346	.....	.....	15.8	
	18	46	14	4	2.56	.39	.....	.....	16	
	16–18	46	70	4.27	3.16	.3187	.379	0	14.5	
Brook Trout.										
Pig liver $.10	11	65	14	3.	5.	.20	.....	0	4.8	B
	12	65	14	1.65	3.89	.257	.....	0	5.	
	14	95	14	2.3	3.36	.297	.....	1.5	6.3	
	14	93	14	1.7	4.	.25	.....	0	7.7	
	15	93	14	5.17	4.	.25	.....	0	9.5	
	11–15		70	2.76	4.05	.2508	.405	.3	6.6	
Brook Trout.										
Beef liver 60%	16	46	14	4.55	6.8	.146	.....	.....	12	C
Flour 40%	17	46	14	5.69	3.8	.261	.....	.....	13.5	
$ .086	17	46	14	3.9	3.7	.268	.....	.....	15.5	
	16–17		42	4.71	4.44	.225	.382	0	13.6	
Brook Trout.										
Beef liver 45%	16	46	14	2.86	2.9	.344	.....	.....	12	D
Meat meal 45%	17	46	14	2.83	2.17	.46	.....	.....	13.5	
Flour 10%	17	46	14	2.8	1.89	.528	.....	.....	15.5	
$ .106	18	46	14	2.45	1.68	.595	.....	.....	15.8	
	18	46	14	2.24	1.62	.615	.....	.....	16	
	16–18		70	2 63	2.	.508	.212	0	14.5	
Brook Trout.										
Beef liver 50%	16	46	14	3.56	3.36	.296	.....	.....	12	E
Fish meal 50%	17	46	14	3.87	2.19	.456	.....	.....	13.5	
$ .082	17	46	14	3.27	2.08	.48	.....	.....	15.5	
	18	46	14	2.35	1.78	.56	.....	.....	15.8	
	18	46	14	2.1	1.58	.63	.....	.....	16	
	16–18		70	3.05	2.19	.485	.179	0	14.5	
Brook Trout.										
Meat meal 35%	18	46	14	1.5	1.8	.55	.....	.....	15.8	F
Fish meal 35%	18	46	14	1.5	1.3	.77	.....	.....	16	
Flour 30%										
$ .043			28	1.5	1.5	.66	.06	0	15.9	
Brook Trout.										
Meat meal 50%	24	133	14	2.6	3.3	.30	.....	.....	3.7	G
Shrimp meal 30%	24	133	13	1.46	2.64	.374	.....	.....	4.5	
Flour 20%										
$ .039			27	2.03	2.97	.337	.1158	0	4.1	
Brook Trout.										
Meat meal 45%	8	63	15	3.7	3.84	.26	.....	2.3	10.26	H
Peanut meal 45%	8	61	15	2.4	4.87	.205	.....	0	8.8	
Middlings 10%										
$ .035			30	3	4.35	.2325	.152	.57	9.5	
Brown Trout.										
Meat meal 40%	17	80	18	2.18	3.22	.31	.....	2.1	14.2	I
Shrimp meal 40%	18	62	18	2.4	2.63	.379	.....	2.	14.7	
Flour 20%										
$ .037			36	2.29	2.92	.344	.108	2.	14.4	
Chinook Salmon.										
Meat meal 85%	4	1000	14	2.7	1.82	.5478	.....	2.2	12.3	J
Liver & kidney	5	1000	14	2	2.6	.377	.....	.6	13.4	
15%	6	1000	28	4.1	2.8	.352	.....	5.	14.5	
$ .059			56	2.9	2.4	.426	.1416	1.9	13.4	

STUDIES ON THE NUTRITION OF FISH: EXPERIMENTS ON BROOK TROUT.*†

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Metabolic studies on aquatic animals have not been numerous. The inherent difficulties of collecting the excreta and measuring accurately the consumed food, both of which are soluble in the water, have doubltess made this subject unattractive to investigators.

In undertaking a nutritional study on the brook trout—a fish remarkably sensitive to slight changes in its environment—the first problem to settle was the practicability of keeping these animals in small aqauria. The trout thrive in rapid streams, and the problem would evidently be beyond solution if they could not be kept in good health in a limited quantity of water. Experience has shown that with sufficient aeration, trout can be kept in as little as four or five liters of water, which need not be changed but once every forty-eight hours, or even at longer intervals. Under such circumstances the trout will not only remain in good condition, but as the experiments here recorded show, will gain weight.

Large museum jars of about twelve inch diameter were used as aquaria, and these offered the fish considerable room for swimming and could be maintained very clean. The jar was closed by a cover which could be clamped tightly to the bottom, and by means of a flat rubber ring the joint was made air-tight. Two round holes drilled in the cover of the jar were fitted with rubber stoppers. Through one of these the aeration tube was passed, while in the other a specially designed cup was inserted containing a measured quantity of standard acid. Compressed air was blown

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through the water and was dissipated as a fine spray by the aeration tube. The air escaping from the jar bubbled through the standard acid contained in the cup. This precaution was taken in order to avoid any possible loss of ammonia from the water by the vigorous current of air.

The contents of the cup were emptied every twenty-four hours and titrated with $\frac{N}{100}$ sodium hydroxide. As no changes in the quantity of acid have been found in the course of many trials, this practice was discontinued as unessential to the accuracy of the experimentation.

The aquaria were submerged in a trough of galvanized iron through which a constant circulation of water of fairly uniform temperature was maintained. The temperature of the aquaria in which the trout sojourned was thus regulated.

The water used in these experiments was exceptionally pure, coming directly from the excellent filters installed in the New York Aquarium. No sediment was formed by this water even upon standing several weeks.

The trout which were experimented on were weighed at the beginning and close of each period. Different methods were tested for obtaining the accurate weight of the fish, and finally the following method was adopted: The trout was picked up with a small, fine net, the adhering water shaken off and allowed to drain for about half a minute. The fish was then transferred cautiously to an aluminum can partly filled with water, the weight of which was accurately determined. With practice it was possible to perform this operation without splashing a drop of water. The can was closed and again weighed with the trout, whose weight was thus gotten by difference. Though the method is not free from certain defects, it had two important advantages over every other method tried, in that, in the first place, no injury was done to the trout; and secondly, with the animal securely in the can, the weighing could be done leisurely. Of course it is assumed that the amount of moisture adhering to the animal has been the same at each weighing. Though this assumption is arbitrary, it has been found, by weighing the animals several times in succession, that the extreme differences do not vary

more than 0.5 per cent. The balance employed in all weighings was sensitive to a milligram with a load of one and one-half kilogram.

Feeding the trout was unquestionably the most difficult and yet the most essential step in the process of accurately measuring their metabolism. The effort, therefore, was made to teach the fish to take their food directly from forceps. Wherever this was feasible, the rest of the experimental procedure was quite simple. In a few instances I was actually successful in so training the trout that they would come to the edge of the aquaria and leaping out of the water, snap the food held with pincers. In this way the washing out of soluble constituents of the food by the water was entirely prevented.

The food was kept in small weighing bottles, and the amount consumed was determined by the difference in the weight before and after feeding. The method of feeding the trout *ad libitum*, had the advantage also that at no time were there unconsumed particles of food left in the aquaria which might favor contamination of the water, and thus greatly affect the significance of the results.

Unfortunately this method of direct feeding could not always be utilized, as will be shown in a later section. The food was generally prepared in large quantity and stored in a frozen condition. The contents of every jar was carefully analyzed, and its composition was checked at least twice in the course of an experiment. Portions of this stock food, enough for several feedings, were put in weighing bottles, and kept in the ice chest in the laboratory.

Usually forty-eight hours after feeding, the trout was removed to a jar with a fresh supply of water, and the old water containing the solid and dissolved excreta of the preceding period was filtered and prepared for analytical treatment.

Large aluminum tumblers, the bottoms of which were perforated with a number of fine holes, were used for this purpose; the tumblers serving as Gooch crucibles. The tumblers were provided with a thick pad of fine glass wool, dried in the oven and weighed. The contents of the aquarium were siphoned into the tumbler and filtered through the glass wool, with the aid of suction, into a large bottle. The glass wool was found very efficient in

retaining even minute particles floating in the water, but the filtered water showed invariably a distinct turbidity. The tumbler with the solid excreta retained in the glass wool was again dried and weighed; thus the weight of dry feces was gotten by difference.

It may be mentioned that the sides and bottom of the aquaria were thoroughly cleaned with a rubber tipped rod, and the wash water added to the filtrate. This was acidified with five drops of sulphuric acid and evaporated to a small bulk. As a rule, the final volume was made up exactly to one liter.

In view of the large quantities of water that it was necessary to handle, the matter of evaporation presented certain technical difficulties. Originally it was attempted to carry out the evaporation at a low temperature (50° C.) with the aid of a rapid current of hot air. This method was very cumbersome, requiring much time. Blank experiments have shown that there was no particular advantage derived from the use of a low temperature. A large steam bath was therefore installed, accommodating a number of evaporating dishes (white enamel) of about twelve liters capacity each. The steam bath was set in the apparatus previously used for evaporating by means of the current of dry air, so that the two methods could be combined at will. Very large quantities of water could in this way be quickly condensed to a small bulk. The condensed water was transferred to a volumetric flask, the evaporating dish thoroughly rinsed with fresh water, and the quantity brought up to a definite volume. This condensed water was again filtered through asbestos to remove such particles as may have gone through the glass wool. This quantity was negligible, but the amount accumulated in the course of an experiment was analyzed and added to the feces. Aliquot portions of the perfectly clear water were used for analysis.

In choosing fine glass wool as a means of separating the solid excreta from the water, two important considerations were borne in mind; owing to the small quantity of feces available, it was very difficult to analyze it, and particularly to obtain a uniform sample. It was urgent, therefore, first to mix the feces with some other material to increase its bulk without interfering with the analysis, and secondly, to make the grinding of the feces possible.

The use of glass wool for this purpose suggested itself after a number of different things have been tried with little or no success.

The glass wool proved particularly ideal as it served as a filtering medium, and could be ground to a thin powder, helping to reduce the feces to a state of extremely fine sub-division and uniform distribution.

These powders, in which the glass represented many times the bulk of the feces, were kept in weighing bottles and were easily sampled for analysis. Nitrogen and fat determinations were made on weighed portions in the usual manner. It may also be mentioned that blank experiments were performed, and the analytical data furnished corrections for the dissolved excreta and feces which were found in experiments with trout.

EXPERIMENTS IN FASTING.

As a preliminary to the feeding experiments, a number of experiments were performed on fasting trout. It has been found that the alimentary tract usually frees itself of all excreta from previous feeding in forty-eight hours. Minute quantities were sometimes eliminated also during the next twenty-four hours, but this was invariably negligible; the fasting, therefore, was generally started forty-eight hours after the last meal. The first protracted fast was performed with a trout weighing 102.9 grams (F-1). In the course of the four weeks of the experiment, no solid excreta were eliminated. The water in the aquaria remained remarkably clean for days, so that it could be changed at long intervals. The nitrogen eliminated in the water was determined for seven-day periods. After twenty-eight days of fasting, the trout weighed 95.7 grams or 7.2 grams less than at the start. The nitrogen eliminated during the first week of fasting was 67.2 mg., but the quantity diminished from week to week, only 45.1 mg. being eliminated during the last week. The average elimination of nitrogen per day and kilogram of weight was 81.3 mg. In the course of four weeks 233.5 mg. of nitrogen was lost. It is evident, therefore, that about one-fifth of the body loss was at the expense of the protein.

The next two experiments were made with trout which had been kept previously in the stock tank and fed freely. When transferred to the experimental aquaria, these fishes vomited much undigested food, and for a few days continued to eliminate large amounts of feces. Trout F-2 in the first week of fasting lost 4.6 per cent of its weight, eliminating 141.9 mg. of nitrogen per day

and kilogram. This very high nitrogen elimination was followed by a decided drop in the next week, when it was only 71 mg.; the loss in weight at the same time having been reduced to 1.3 per cent. During the entire two-weekly period of fasting 5.9 per cent of the body weight was lost, and the daily nitrogen elimination per kilogram of fish was 105.5 mg. The very high nitrogen elimination during the first few days of fasting which, in this case, was preceded by abundant and unrestricted feeding, will be observed in several other experiments. This condition is met with also in the case of the higher vertebrates.

In experiment F-3 it will likewise be observed that the nitrogen elimination reached a very high level of 132.2 mg. per day and kilogram, but the fast was not continued further with this animal.

Experiment F-4 presents essentially the same picture. This trout was used in a long feeding experiment, and for weeks it was fed regularly and *ad libitum*. It was then subjected to a fast of two weeks' duration, during which time it had lost 9.3 per cent of its weight. The nitrogen eliminated in the first and second week shows that it was twice as large during the former, being 155.9 mg. nitrogen per day and kilogram for the first seven days, and only 79.3 mg. for the next seven days. This large loss of nitrogen observed invariably upon changing from an abundant diet to fasting, especially in the case of trout F-4 which for a month previous to the fast has been eliminating a fairly constant amount of nitrogen daily, brings up again the question of the circulating protein which, when the income of new food material is stopped, is the first to be consumed.

Experiment F-5 like the first of the series, is interesting because this trout was not on an abundant diet previous to the fast. Its nitrogen elimination for eight days was 91.6 mg. per day and kilogram of body weight. We may regard, therefore, the elimination of 80 to 90 mg. per day and kilogram as the normal nitrogen catabolism of the Brook Trout. (See Table I.)

FEEDING RAW BEEF HEART.

Raw beef heart cut in fine strips about one cm. long was fed directly from forceps. The results of an experiment which lasted over two months are recorded in Table II. During this time the excreta for every forty-eight hours were collected and analyzed

separately. In the course of the first month, it will be seen, the trout gained 77.3 per cent in weight. It consumed 85.34 grams of beef heart, and the excretion from day to day showed remarkable constancy. It will be noted also that the amount of nitrogen in the feces was almost invariably 10 per cent of the dry fecal matter, and this proportion coincides with that found in the feces of mammals on a pure meat diet. The dry feces constituted about 5 per cent (Table VI) of the dry material ingested with the food. The utilization of the food—protein and fat—has been almost constant throughout this part of the experiment. Of the 2.8981 grams of nitrogen fed, 0.9329 grams was retained. In the absence of experiments on the respiratory exchange, the retention of fat could not, of course, be worked out. Considering the amount lost with the feces, 96.1 per cent of the consumed protein was utilized, and 94.5 per cent of the fat. Not only has the utilization of the food through digestion been good, but as the "Index of Growth" (ratio between increase in weight and quantity of consumed food per kilogram and twenty-four hours) will show, it furnished a considerable proportion of its material to the building up of the body tissues.

The consumption of the trout per day and kilogram of weight amounted to 37.5 grams of food, while the increase in body weight per day and kilogram was 17.4 grams. In other words, 46.5 per cent of the food material was added to the organism (See Table VI). The trout was then allowed to fast for a fortnight, (F-4, Table I), in order to find out how this would affect the digestive power and general condition of the animal whose metabolic exchange had been carefully established by the previous study.

Upon resuming feeding, the trout gained 15.7 per cent in two weeks. During the first four days of re-alimentation, the very small amount of nitrogen in the water (urine) is very marked. During the first part of the experiment, the urinary nitrogen represented on the average 63.9 per cent of the total nitrogen consumption, but during the first and second forty-eight hours following the fast, it was 39.7 and 57.2 per cent respectively. There was thus undoubtedly a retention of nitrogen. As the elimination for the next forty-eight hours shows, this this retention was only temporary.

During this third two-day period, the urinary nitrogen represented 106.1 per cent of the consumed nitrogen. In other words, the nitrogen ingested since the fast was broken, was not excreted until six days later. The nitrogen elimination then gradually diminished, but even after two weeks, it was still 10 per cent higher than in the first part of this experiment.

An examination of the feces also revealed that the amount of dry excreta has become 50 per cent greater than during the preceding period, and furthermore that the feces became very fatty, in fact from the fifth until the tenth day of resumed feeding, the per cent of fat was extremely high; this apparently being due to delayed elimination of undigested fat rather than to a progressive impoverishment of the digestive functions. In this respect there is almost a direct relationship to the excretion of urinary nitrogen. The utilization of nitrogen during these two weeks was 94.8 per cent, not essentially different from the degree of utilization in the pre-fasting period, but the fat utilization was only 91.7 per cent.

That the general condition of the trout was impaired by the starvation, is indicated best by the lowering of the "growth index" (See Table VI). During these fifteen days the trout received 26.7 grams of raw beef heart per day and kilogram of body weight, but it gained only 9.73 grams in weight; in other words, the "growth index" was 36.5 per cent as compared to 46.5 per cent of the earlier part of the experiment.

The experiment recorded in the next table presents much similarity to the preceding one. Six small fingerlings weighing all together only 33.6 grams, were used. During the first part of the experiment lasting twenty-six days, these small trout were fed thirteen times and the excreta were collected and separately analyzed four times during that period. A glance at the tabulary summary (III) of the results will show that the animals consumed 25.41 grams of the raw beef heart, and gained 11.13 grams in weight. The quantity of dry feces eliminated in that time was 3.52 per cent of the total dry ingested food, and contained 21.2 mg. of nitrogen. The protein of the food, therefore, was utilized to the extent of 97.5 per cent, and the fat 96.2 per cent. The "index of growth" was 42.7 showing that the fingerlings were growing at a favorable rate.

Owing to the accidental death of one of the experimental animals, the experiment was renewed with the five remaining

survivors, and continued for another twenty-one days. During this time the excreta were collected and analyzed five times. A short fast of four days intervened between the first and second part of this experiment. The composite weight of the five fingerlings was 34.8 grams, and these increased 11.3 grams in the twenty-one days, or considering the average weight at the beginning and closing of the entire experiment, the fingerlings gained about 66 per cent in weight.

By reviewing the data pertaining to the second part of the experiment, certain differences will be observed as compared with the results obtained in the first part, which to a certain extent substantiate the experience gained in the preceding experiment 000.5.

In the first place the ratio of dry feces to the dry matter of food is 50 per cent higher, and this increase in the fecal discharge runs parallel to the diminished utilization of the nutriment. The conclusion, therefore, is warranted that in this instance also the digestive activity was somewhat impaired by the short fast. The growth capacity, was not affected in this instance, the fingerlings having grown more in the three weeks following the fast than during the twenty-six days preceding it. The gain in weight represented 49.8 per cent of the quantity of food per day and kilogram, as compared with 42.7 of the earlier period.

Two things must be borne in mind in connection with these experiments: In both instances the evidence clearly indicates that fasting is deleterious to the digestive function of the trout. The difference in effect upon subsequent growth may probably be due to the fact that in experiment 000.5, the intervening fast was a much more protracted one.

The last experiment on the effect of feeding raw beef heart is particularly interesting, as this was performed on the trout which had undergone a preliminary fast (F-1). In the course of fifteen days of the experiment, this trout consumed 27.71 grams of food with a content of 7.047 grams of dry matter. Examining the last three vertical columns of Table IV, the thing which strikes one's attention at once is the high proportion of fat in the feces; then the apparent retention of nitrogen as is shown by the low nitrogen content of excretions passed during the first several days after

feeding was resumed. That the retention was purely temporary is seen from the fact that within the next few days the elimination was abnormally high, especially between the sixth and ninth day when it became actually 30.8 per cent more than the nitrogen contained in the food for that period. This delayed elimination of nitrogenous waste points to the possibility that the excretory mechanism of the trout suffered an injury in consequence of starvation, which it required several days, when food was given, to restore to normal functioning.

The similarity of the results obtained in these three experiments is very striking, those of 000.5 and 000.7 being practically identical.

The dry feces formed a much greater per cent of the dry matter consumed with the food, than in any of the previous experiments (9.95 per cent). The utilization of the protein during the entire fifteen day period is 94.4 per cent, which compares very favorably with the extent of utilization observed in the other experiments. The utilization of the fat which has been reduced to only 83.8 per cent demonstrates once more, and more poignantly than in any of the previous experiments, the particularly deleterious influence of fasting upon fat utilization. The reason for this must unquestionably be looked for in the longer duration of the fast. To explain these facts it may be necessary to assume that a more lasting damage was done to the glandular structures of the animal, the pancreas and the liver, which lead to a defective digestion and absorption of fats. Further investigation of this question would at any rate be desirable.

In spite of the low degree of utilization of the food materials, the "Index of Growth" was 50.1; in other words, half of the nutrient material fed has actually gone towards the building up of the body tissues. This result is of much significance, inasmuch as it adds further proof for the idea that neither the utilization of the food in digestion, nor indeed the actual quantity consumed, determines the extent of the resulting growth of the organism. The trout in this experiment increased in weight at a greater rate than in any other of this series, while actually consuming the smallest quantity of food.

FEEDING COOKED BEEF HEART.

In the practical feeding of fish in hatcheries, the question is frequently asked, "shall the food be fed raw or cooked?" The objection to cooked food on the ground that it is not the natural condition of the fishes' nourishment, may well be dispensed with. Feeding fish in hatcheries is a problem in domestication, and the merits of a dietary system must be judged not by whether it resembles or deviates from the state of things in nature, that is, wild nature, but by the results which can actually be achieved with it. To anticipate what will be brought out in the description of the following experiments, cooked food is neither more nor less utilized than the raw food, though possibly it has less growth-promoting quality. For one thing it is not as palatable to the fish as the raw food, and in my experience, the trout ate it much less willingly and in smaller amounts. In only one respect does feeding of cooked food present a decided advantage. On raw food the feces are gelatinous and fairly massive, while those resulting from cooked food are more or less dry and scanty. The feces therefore have no tendency to adhere to the sides of the aquaria, being in well formed compact masses. Contamination of the water was, therefore, never observed when cooked food was fed, and it remained remarkably clear for a number of days.

The food was put up as before, except that it was brought to a quick boil with a small volume of water, the fluid completely drawn off, and the meat packed in stock jars, refrigerated and analyzed as usual.

Experiment 00.2 was made on the same trout which served in experiment 000.5. The result of these two experiments are, therefore, well suited for comparison. The animal was fed on the cooked beef heart for a considerable time to get it thoroughly accustomed to this food before the actual metabolic study was begun. The trout did not relish cooked food, and at best would eat only small quantities. In the thirty-eight days which this experiment lasted, the trout consumed only 23.9 grams of the food; the feces for this period contained 51.9 mg. nitrogen and 34. mg. of fat. These two constituents of the diet were therefore utilized to the extent of 95.7 and 96.1 per cent respectively, which is very close to the values (96.1 and 94.2) which were found on

raw meat. The per cent of nitrogen and fat in the dry feces is much greater than on a diet of raw meat, and this condition is very general as can be seen by comparing the data in columns 5 and 6 of Table VI. This very high percentage, however, is of no significance, being merely due to the fact that the feces is more compact and dry when the trout are kept on the cooked meat regime. It is more significant that the amount of dry feces presents the same proportion of the dry matter of the consumed food (3 to 4 per cent) no matter whether the food has been cooked or not.

The results of experiment 00.3 are essentially the same, though this trout has shown a somewhat smaller increase in weight. Experiment 00.4 which lasted forty-eight days, was made on a trout which had been fasting a week before the experiment commenced. The protein of the food was utilized as usual—95.7 per cent—but only 92.5 per cent of the fat was utilized. This is further confirmation of the point emphasized already on several occasions in this paper of the defective utilization of fat by trout that have undergone even a brief starvation. The amount of food this trout ingested per day and kilogram of body weight was 10.11 grams. The daily increment in weight per kilogram was 4.25 grams; in other words, the growth index was 42. When we compare the relative value of cooked and raw meat as the diet for trout, we can indicate the following advantages of the latter: Its greater palatability and greater growth-promoting quality. This can be seen at once when the average "growth index" of the experimental series 000.5 to 000.7 which is 45, is compared with the same of the experimental series 00.2 to 00.4 which is only 39. This might perhaps be objected to on the ground that the difference in the body weight increments is due rather to the great difference in the quantity of food which the trout have consumed in these two series of experiments. It must be recalled, however, that the "growth index" does not furnish information as to the actual or absolute increment in body weight, but indicates the fraction of the nutrient material which has become permanently incorporated as a part of the organism. The two kinds of food have been apparently ample in amount to insure not only maintenance, but a further increase in weight, but in the case of the cooked beef heart a smaller relative increase in body weight was secured.

It is possible that the lesser effect of the latter in producing growth was due to the fact that in the process of boiling, some of its "water soluble" growth-stimulating stuffs have been dissolved out. The fact that the food which has been boiled and thus lost a large part of its water content was as well utilized by the trout as raw meat, suggests that it would be practicable to utilize thoroughly desiccated food as trout diet. This soaked in water before feeding would probably retain both its gustatory quality, as well as its growth-promoting quality. This could doubtless become an excellent method for preparing on a large scale and distributing the food for trout hatcheries. Experiments which were planned with a view of studying the metabolic value of such desiccated foods, remained unperformed owing to the unexpected interruption of the investigation.

FEEDING BEEF LIVER.

Beef or pig liver is one of the staple diets in trout hatcheries, and a series of experiments were started to study its nutritive value. The liver was freed from all blood vessels and ducts, and the parenchyma alone was frozen solid and ground in a meat grinder to a fine pulp. The food was then kept in the refrigerator and analyzed as usual. Unfortunately it was impossible to feed this food directly from forceps as was done with the beef heart. It was necessary instead to throw a quantity of food into the aquaria and leave it there for a half hour. The trout was then removed to another aquarium with fresh water, in which the excreta were collected, while the unconsumed food was collected over glass wool in a large filtering tumbler. The filtrate was made up to a definite volume, of which aliquot portions were used to determine the nitrogen, fat and sugar that was dissolved out from the food by the water. The solid residue was dried at 100°, powdered and the composite sample for the entire experimental period was analyzed in the usual way.

Knowing the quantity of food thrown into the aquarium, the amounts of nitrogen, fat and carbohydrate were computed from the analytical data pertaining to the particular food sample. From this was subtracted the amounts of nitrogen, fat and carbohydrate both dissolved in the water and found in the solid residue.

The amount of each constituent consumed was then determined by the difference.

In his study of the digestion of fish, Knauthe* made use of this method exclusively. Apart from the disadvantage which it shares with all indirect methods, the method is time-consuming and presents so many unforeseen difficulties as to render the results at times valueless.

In the matter of recovering the fat, Knauthe's procedure, though very simple, consisting merely in extracting an aliquot portion of the water with ether, on closer examination proves of little or no value. Knauthe has not performed blank experiments to determine how closely the recovered amount corresponded with that washed out by the water; he therefore had no occasion to be apprehensive about the acceptability of his results.

As was pointed out in an earlier section, I considered the performance of blank experiments as very essential, and have relied on these in deciding whether or not the analytical procedure in use was adequate. By following Knauthe's method, I found that the results were so widely off the expected value as to make them absolutely worthless.

It will be noted further that in all the experiments, the animals were allowed to remain in the feed jars one-half hour, after which they were removed to fresh water. Knauthe on the other hand, allowed his animals to remain in the aquaria containing food for a very long time, and separated mechanically the feces from the solid food particles. It need hardly be pointed out that such a procedure is altogether too crude to warrant great confidence in the significance of experimental results. The bacterial growth in suspensions of nutrient material would be sufficient to vitiate the results. In a number of blank experiments a weighed quantity of liver pulp was put in the aquaria (without trout), left there a half hour as usual, then the solid residue and the filtered water were analyzed. In the case of the nitrogenous material and the sugar, the recovery was complete within less than one per cent, but in the matter of the fat, as determined by direct extraction of the water with ether, such low values were usually gotten as to render the data of no importance. The need of a different and

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better method was keenly appreciated, and attempts in this direction were started. The main difficulty to be remembered, was in the fact that the relatively small quantity of fat had to be recovered quantitatively from a large bulk of water.

All the determinations were in duplicate. The nitrogen was determined by the Kjeldahl method, and one-tenth portions of the entire water were used for the analysis. The sugar was determined by Bertrand's method in one-quarter portions. The sugar analysis was made on the perfectly clear filtrate, which was obtained by treating the water with aluminum cream to free it of the protein. On extracting this clear filtrate with ether, I invariably found that there was no fat present. This suggested a method of determining the fat, which is evidently carried down with the aluminum precipitate. By drying this voluminous gelatinous precipitate, powdering it and extracting it with ether, it was hoped that accurate results on the fat suspended in the water would be obtained. While this method, or some similar modification of it, has good possibilities, a number of difficulties were encountered in its practical application, which were not entirely removed before this work had come to an unexpected halt, and the matter of utilization of the fat from liver remained untouched in this investigation.

The feeding of liver has not met with success in my hands. A number of circumstances have probably conspired to make these experiments less definite than those of the preceding series. Many experiments terminated in failure, owing to the death or ill condition of the trout. Three experiments are recorded in Table VII, and these will perhaps throw light on the question of liver as a trout food. It will be seen that the trout did not grow as well as those fed on beef heart, indeed one specimen lost 8.5 grams. The utilization of protein (nitrogen) was very low (90.5 to 83.6 per cent). The utilization of glucose shows likewise wide fluctuation from 96.9 to 86.9 per cent. The utilization of the fat ranged about 90 per cent, but as the analytical data were not entirely reliable, these results have not been included in the table.

Before concluding, one other point should be mentioned. In the course of the half hour during which the liver pulp remained in the aquaria, as much as 60 to 75 per cent of its nitrogenous

material had been dissolved by the water. It is a conservative estimate that 50 per cent of the fat was washed out, and none of the glucose was left in the residue, it having been entirely dissolved out by the water. This happened in spite of the fact that the food was contained in a limited quantity of water, agitated only by the swimming movements of the trout.

In hatcheries where the trout are kept in rapid streams of water, it is questionable if a food which will so easily give up its components to the water, is a particularly valuable diet. Its inferiority to beef heart as a dietary article for trout is amply demonstrated by the results of the experiments here recorded.

TABLE I. Experiments in Fasting.

No. of Experiment	Period of Fasting	Av. Temp. of Water	Weight		Loss in Weight	Total N. Excreted	N. Excretion per Day	N. Excretion per Day and kgm.	Fat Excretion (Total)	Fat Excretion per Day and kgm.
			Initial	Final						
		° C.	g.	g.	%	g.	g.	g.	g.	g.
F-1	I.25–II.1	16.3	102.9	.....	.....	0.0672	0.0096	0.0941	.....	.....
	II.1–II.8		.....	.....	.....	0.0629	0.0090	0.0900	.....	.....
	II.8–11.16		.....	.....	.....	0.0583	0.0073	0.0745	.....	.....
	II.16–II.23		.....	95.7	7.0%	0.0451	0.0065	0.0670	.....	.....
						0.2335	0.0081	0.0813	.....	.....
F-2	VI.4–VI.11	17.2	52.2	49.7	4.6%	0.0464	0.0072	0.1419	0.0043	0.0061
	VI.11–VI.18		49.7	49.1	1.3%	0.0243	0.0035	0.0710	.....	.....
						0.0042	Feces			
					5.9%	0.0749	0.0054	0.1055	.....	.....
F-3	VI.5–VI.12	17.2	82.4	81.0	1.7%	0.0695	0.0099	0.1212	.....	.....
						0.0063	Feces		0.0082	0.0143
						0.0758	0.0108	0.1322	.....	.....
F-4	II.10–II.17	16.7	91.1	82.6	9.3%	0.0965	0.0138	0.1559	.....	.....
	II.17–II.24					0.0458	0.0065	0.0793	.....	.....
						0.1423	0.0102	0.1171	.....	.....
F-5	IV.22–IV.30	16.6	57.4	56.3	1.9%	0.0415	0.0052	0.0916	.....	.....

TABLE II. EXPERIMENT 000.5. FEEDING RAW BEEF HEART.

Av. Temp.	Period	Initial or Final Wt.	Change of Wt.	Amount of Food	N. Intake	Fat Intake	Dry Feces	N. in Feces	Fat in Feces	N. in Water (Urine)	Total N. Eliminated	N. in Feces in Relation to N. Intake = 100	Fat in Feces in Relation to Fat Intake = 100	N. in Water in Relation to N. Intake = 100
° C.		g.	%	g.	g.	g.	g.	g.	g.	g.	g.			
16.0	I.9–I.13	51.4	.....	6.07	0.2057	0.1718	0.0625	0.0153	0.0328	0.1080	0.3263	2.84	7.30	52.5
17.3	I.13–I.17	.....	.....	9.80	0.3324	0.2778	0.0840			0.2030				61.1
17.9	I.17–I.21	.....	.....	9.10	0.3079	0.2572	0.0982	0.0269	0.0302	0.2085	0.4774	3.81	5.12	67.7
16.3	I.21–I.25	.....	.....	11.74	0.3983	0.3328	0.1568			0.2420				60.8
15.8	I.25–I.27	.....	.....	5.57	0.1890	0.1578	0.0792	0.0068	0.0099	0.1211	0.1279	3.60	6.21	64.1
16.8	I.27–I.29	.....	.....	5.73	0.1995	0.1624	0.0862	0.0085	0.0094	0.1314	0.1399	4.27	5.79	65.9
15.1	I.29–I.31	.....	.....	5.94	0.2015	0.1683	0.0829	0.0084	0.0097	0.1338	0.1422	4.17	5.75	66.4
16.2	I.31–II.2	.....	.....	5.98	0.2029	0.1693	0.0835	0.0085	0.0102	0.1423	0.1338	4.19	6.02	65.9
15.3	II.2–II.4	.....	.....	5.48	0.1859	0.1552	0.0692	0.0075	0.0082	0.1208	0.1283	4.03	5.22	65.0
16.4	II.4–II.6	.....	.....	7.43	0.2521	0.2105	0.1060	0.0105	0.0093	0.1691	0.1586	4.17	4.42	62.9
16.0	II.6–II.8	.....	.....	7.13	0.2409	0.2021	0.0985	0.0104	0.0061	0.1658	0.1762	4.32	3.01	68.8
15.7	II.8–II.10	91.1	.....	5.37	0.1820	0.1521	0.1050	0.0106	0.0139	0.1250	0.1356	5.82	9.13	68.7
16.4	I.9–II.10	39.7	+77.3	85.34	2.8981	2.4173	1.1120	0.1134	0.1397	1.8518	1.9652	3.91	5.78	63.9
16.7	II.10–11.24	82.6	—9.33	Fasting										
17.5	II.24–II.26	82.6	.....	4.48	0.1613	0.1219	0.0430	0.0048	0.0039	0.0641	0.0689	2.98	3.20	39.7
13.8	II.26–II.28	.....	.....	5.04	0.1814	0.1372	0.0680	0.0076	0.0061	0.1038	0.1114	4.19	4.45	57.2
15.0	II.28–III.2	.....	.....	4.06	0.1462	0.1105	0.0905	0.0082	0.0117	0.1551	0.1633	5.61	10.59	106.1
14.6	III.2–III.4	.....	.....	6.03	0.2038	0.1293	0.1210	0.0121	0.0169	0.1705	0.1826	5.94	13.07	83.2
15.4	III.4–III.6	.....	.....	4.40	0.1584	0.1198	0.1090	0.0107	0.0127	0.1318	0.1425	6.76	10.60	83.2
16.6	III.6–III.8	.....	.....	5.09	0.1832	0.1385	0.1160	0.0113	0.0109	0.1292	0.1405	6.17	7.89	70.5
15.2	III.8–III.11	95.5	.....	6.54	0.2354	0.1780	0.1390	0.0113	0.0151	0.1732	0.1845	4.80	8.48	73.6
15.4	II.24–III.11	12.9	+15.7	35.64	1.2695	0.9352	0.6865	0.0660	0.0773	0.9277	0.9937	5.20	8.27	73.08

TABLE III. Experiment 000.6. Feeding Raw Beef Heart.

Av. Temp.	Period	Initial or Final Wt.	Change of Wt.	Amount of Food	N. Intake	Fat Intake	Dry Feces	N. in Feces	Fat in Feces	N. in Water (Urine)	Total N. Elim-inated	N. in Feces in Relation to N. Intake = 100	Fat in Feces in Relation to Fat Intake = 100	N. in Water in Relation to N. Intake = 100
° C.		g.	%	g.	g.	g.	g.	g.	g.	g.	g.			
17.1	I.19–I.27	33.6	.....	4.74	0.1609	0.1344	0.0368	0.0036	0.0056	0.1344	0.1380	2.24	4.17	83.5
15.9	I.27–II.2	.....	.....	5.09	0.1727	0.1443	0.0540	0.0047	0.0056	0.1245	0.1292	2.72	3.88	72.1
16.2	II.2–II.8	.....	.....	7.23	0.2455	0.2051	0.0566	0.0050	0.0069	0.1730	0.1780	2.04	3.36	70.5
16.1	II.8–II.14	44.7	.....	8.35	0.2871	0.2404	0.0864	0.0079	0.0092	0.1962	0.2041	2.75	3.41	68.4
16.3	I.19–II.14	11.1	+33.4	25.41	0.8662	0.7239	0.2338	0.0212	0.0273	0.6281	0.6493	2.45	3.77	72.5
.....	II.14–II.18	.....	.....	Fasting										
16.3	II.18–II.23	34.8	.....	2.84	0.1022	0.0782	0.0375	0.0037	0.0067	0.1074	0.1111	3.62	8.57	105.1
17.5	II.23–II.27	.....	.....	4.00	0.1440	0.1104	0.0763	0.0074	0.0099	0.0982	0.1056	5.14	8.97	70.0
14.8	II.27–III.3	.....	.....	4.72	0.1699	0.1305	0.0650	0.0066	0.0097	0.1082	0.1148	3.89	7.43	63.7
15.2	III.3–III.7	.....	.....	5.86	0.2110	0.1618	0.0935	0.0099	0.0139	0.1335	0.1434	4.70	8.06	63.3
15.9	III.7–III.11	46.1	.....	5.53	0.1990	0.1525	0.1025	0.0102	0.0119	0.1365	0.1467	5.13	7.80	68.6
15.9	II.18–III.11	11.3	+32.8	22.95	0.8261	0.6334	0.3748	0.0378	0.0521	0.5838	0.6216	4.58	8.23	70.7

TABLE IV. EXPERIMENT 000.7. FEEDING RAW BEEF HEART.

Av. Temp.	Period	Initial or Final Wt.	Change of Wt.	Amount of Food	N. Intake	Fat Intake	Dry Feces	N. in Feces	Fat in Feces	N. in Water (Urine)	Total N. Eliminated	N. in Feces in Relation to N. Intake = 100	Fat in Feces in Relation to Fat Intake = 100	N. in Water in Relation to N. Intake = 100
° C.		g.	%	g.	g.	g.	g.	g.	g.	g.	g.			
17.7	II.23–II.26	95.7	.....	8.00	0.2880	0.2209	0.0460	0.0050	0.0355	0.1214	0.1264	1.74	16.08	42.2
14.1	II.26–III.1	.....	.....	3.56	0.1281	0.0983	0.1350	0.0128	0.0090	0.1168	0.1296	10.00	9.16	91.2
14.7	III.1–III.4	.....	.....	1.95	0.0702	0.0540	0.1280	0.0123	0.0265	0.0918	0.1041	17.52	49.1	130.8
15.9	III.4–III.7	.....	.....	5.40	0.1943	0.1490	0.1300	0.0113	0.0185	0.1326	0.1439	5.82	12.42	68.3
16.0	III.7–III.10	109.5	.....	8.78	0.3162	0.2424	0.1920	0.0148	0.0341	0.1944	0.2092	4.68	14.07	61.5
15.7	II.23–III.10	13.8	+14.5	27.71	0.9968	0.7645	0.6310	0.0562	0.1236	0.6570	0.7132	5.64	16.16	65.9

TABLE V. Feeding Cooked Beef Heart.

No. of Experiment	Av. Temp.	Period	Initial or Final Wt.	Change of Wt.	Amount of Food	N. Intake	Fat Intake	Dry Feces	N. in Feces	Fat in Feces	N. in Water (Urine)	Total N. Eliminated	N. in Feces in Relation to N. Intake = 100	Fat in Feces in Relation to Fat Intake = 100	N. in Water in Relation to N. Intake = 100
	° C.		g.	%	g.	g.	g.	g.	g.	g.	g.	g.			
00.2	16.7	IV.20–IV.30	100.6	.....	3.510	0.1776	0.1325	0.0330	.....	.....	0.1462	.....	.....	.....	82.3
	16.3	IV.30–V.7	.....	.....	5.715	0.2801	0.1982	0.0620	.....	.....	0.1859	.....	.....	.....	66.4
	16.3	V.7–V.14	108.5	7.81	4.750	0.2404	0.1793	0.0670	.....	.....	0.1809	.....	.....	.....	75.3
	15.4	V.14–V.21	.....	.....	5.175	0.2591	0.1875	0.0860	.....	.....	0.2069	.....	.....	.....	79.9
	16.0	V.21–V.28	110.6	2.0	4.760	0.2409	0.1796	0.0554	.....	.....	0.1841	.....	.....	.....	76.4
	16.1	IV.20–V.28	10.0	9.85	23.910	1.1981	0.8771	0.3034	0.0519	0.0340	0.9040	0.9559	4.33	3.88	75.5
00.3	16.2	IV.30–V.7	60.9	.....	5.37	0.2534	0.1811	0.0420	.....	.....	0.1682	.....	.....	.....	66.4
	16.3	V.7–V.14	66.6	9.02	5.12	0.2359	0.1746	0.0462	.....	.....	0∫1804	.....	.....	.....	76.5
	15.4	V.14–V.21	.....	.....	4.78	0.2415	0.1803	0.0874	.....	.....	0.1935	.....	.....	.....	80.1
	16.0	V.21–V.28	67.4	1.2	4.96	0.2510	0.1871	0.0432	.....	.....	0.1839	.....	.....	.....	73.3
	16.0	IV.30–V.28	6.5	10.66	19.29	0.9818	0.7231	0.2188	0.0401	0.0283	0.7260	0.7661	4.09	3.91	73.9
00.4	16.2	IV.30–V.7	56.3	.....	1.750	0.0886	0.0660	0.0200	.....	.....	0.0699	.....	.....	.....	78.9
	16.3	V.7–V.14	.....	.....	4.645	0.2350	0.1753	0.0516	.....	.....	0.1449	.....	.....	.....	61.7
	15.4	V.14–V.21	60.9	.....	4.585	0.2316	0.1728	0.0682	.....	.....	0.1583	.....	.....	.....	68.4
	16.0	V.21–V.28	62.6	.....	2.380	0.1204	0.0898	0.0238	.....	.....	0.0999	.....	.....	.....	82.9
	16.0	IV.3–V.28	6.3	11.21	13.36	0.6756	0.5039	0.1636	0.0265	0.0378	0.4730	0.4995	3.92	7.50	70.1
	16.8	V.28–VI.1	62.6	.....	3.15	0.1594	0.1188	0.0615	.....	.....	0.1097	.....	.....	.....	68.9
	15.6	VI.1–VI.5	.....	.....	3.57	0.1806	0.1347	0.0690	.....	.....	0.1230	.....	.....	.....	68.1
	17.8	VI.5–VI.9	64.8	.....	3.60	0.1822	0.1358	0.0450	.....	.....	0.1419	.....	.....	.....	77.9
	16.5	VI.9–VI.13	67.8	.....	4.01	0.2029	0.1513	0.0475	.....	.....	0.1074	.....	.....	.....	52.9
	17.4	VI.13–VI.17	69.10	.....	2.73	0.1381	0.1030	0.0688	.....	.....	0.1359	.....	.....	.....	98.4
	16.8	V.28–VI.17	6.5	8.31	17.06	0.8632	0.6436	0.2918	0.0763	0.0479	0.6179	0.6942	8.84	7.45	71.5
	16.4	IV.30–VI.17	12.8	22.74	30.42	1.5308	1.1475	0.4554	0.1028	0.0857	1.0909	1.1937	6.68	7.47	70.9

TABLE VI. SUMMARY.

Experiment	Duration	Nature of Food	Ratio of Dry Feces to Dry Matter of Food	Per cent of N.	Per cent of Fat	Per cent of Utilization		Average Intervals Between Feedings	Grams of Food Consumed	Increase in body wt.	Index of Growth
				In Dry Feces		Protein	Fat		per Kg. and 24 Hours		
	Days		%	%	%	%	%	Hours	g.	g.	
000.5 (a)	32	Raw beef heart	4.99	10.0	10.0	96.1	94.2	48	37.5	17.4	46.5
000.5 (b)	15	"	7.80	9.6	9.3	94.8	91.7	48	26.7	97.3	36.5
000.6 (a)	26	"	3.52	9.1	6.4	97.5	96.2	48	25.0	106.7	42.7
000.6 (b)	21	"	6.42	10.0	10.0	95.4	91.8	48	27.0	134.5	49.8
000.7	15	"	8.95	8.9	17.9	94.4	83.8	48	18.0	170.2	50.1
00.2	38	Cooked beef heart	3.4	19.1	12.7	95.7	96.1	41	6.0	2.5	41.7
00.3	28	"	3.0	20.9	14.6	95.9	96.1	34	10.78	36.3	33.7
00.4	48	"	3.7	22.6	18.8	95.7	92.5	36	10.11	42.5	42.0

TABLE VII. Feeding Raw Beef Liver.

Experiment	Av. Temp.	Period	Initial and Final Wt.	Change in wt.	Amount of food	N. Intake	Glucose Intake	N. in Feces	Fat in Feces	Sugar in Feces	N. in Water (Urine)	Total N. Eliminated	N. in Feces in Relation to N. Intake=100	N in Water in Relation to N Intake=100	Sugar in Feces in Relation to Sugar Intake=100
	° C.	Days	g.	%	g.	g.	g.	g.	g.	g.	g.	g.			
02a	14	14	35.8 38.1	+ 6.4	23.58	0.2470	0.3285	0.0235	0.0540	0.0432	0.1520	0.1755	9.5	61.5	13.1
03	16	21	59.1 50.6	—14.4	84.83	0.6114	0.4100	0.1005	0.1246	0.0127	0.4413	0.5418	16.4	72.1	3.1
03a	16.5	13	49.4 50.3	+ 1.8	51.01	0.2750	0.1295	0.0420	0.0704	0.0125	0.2530	0.2950	15.3	92.0	9.7

MINNESOTA'S EXPERIMENT IN STATE FISHING.

By Carlos Avery,
St. Paul, Minn.

Immediately upon the entry of the United States into the war a great hue and cry arose urging relaxation of the fishing laws and regulations so as to permit the people to take fish anywhere and in any way that they chose. The pretext that the fish were greatly needed for food as substitute for meats was used as a plausible argument. This demand grew more and more insistent until it constituted a real menace to the well established conservation policy of the state.

Here is a sample expression from a banker in a country town, from a letter addressed to the Safety Commission: "Could not your Honorable Commission take up this matter with the State Game and Fish Commissioner and have the present game laws taken off for the present at least and allow us all to take whatever fish we could make use of for our own use in any way they could be caught." This is another: "I hope that you will not be influenced by a few moneyed men, but will give the settlers their rights to kill game and catch fish at any time regardless of game laws."

The Governor, the Safety Commission and the Game and Fish Commissioner were deluged with such appeals during 1917, but after the state fishing got under way they gradually subsided until now such a letter is rarely received.

The State War Board, in Minnesota known as the Public Safety Commission, which was appealed to, gave the Game and Fish Department an opportunity to make recommendations. The plan which is now in operation was recommended by the Game and Fish Commissioner as a substitute for the wide-open plan generally proposed. The Safety Commission approved by formal order, named the Game and Fish Commissioner as their agent to carry on the work according to his discretion, and appropriated $1,000.00 as his capital stock on which to commence business.

With this small beginning the enterprise started and has been self-supporting from the outset, all equipment having been purchased from the fund accumulated from the small margins on fish sales. The value of equipment and other assets at the end of the first year will approximate $25,000.00.

FISHERIES, WHERE OPERATED.

Red Lake, the largest lake in the state, is a comparatively shallow body of water some 440 square miles in area. It is nearly all included in the Red Lake Indian Reservation, abounds in certain varieties of fish and has never been fished for market. By agreement with the Department of Indian Affairs, whereby the Indians of the reservation are to receive certain benefits, arrangements were made to open up state fisheries in these waters.

The intention was, when the State fishing was first inaugurated, to confine it exclusively to Red Lake. It soon became apparent that this would result in a financial loss for several months and it was realized that in the great number of lakes of the state there were certain varieties of fish which were used but little, if at all, and there was no practical method recognized by law to take them in quantities. So we began to take tullibees with gill nets, bullheads with hoop nets and pickerel with gill nets and spears, where they were abundant and a considerable portion could be spared for this purpose.

In this way the demand for fish was met and the enterprise was made self-sustaining, while the preparation was going on for more extensive operations in Red Lake. It was not until late in May that pound nets were finally set in Red Lake, since when other state fishing has been gradually suspended as unnecessary. The fish were found to be so abundant that during May and June from two to four thousand pounds at a lift were taken from the pound nets in use.

No fishing has been done anywhere that would interfere or conflict with regularly licensed commercial fishing or tend to deplete any waters of any species, or to interfere with or injure angling. It has been the policy to take only such species as are of value chiefly as food fish and of little or no value as game fish.

The production of fish in the various localities in which operations have been carried on has aggregated as follows:

Nov. 1, 1917, to Aug. 31, 1918.

Red Lake	538,644	lbs.
Bena District, including waters of Cass, Winnibigoshish, and Leech Lakes and tributaries	281,046	"
Miscellaneous, including carp fishing in the Minnesota River	147,880	"
Mille Lac	42,808	"
Winton District, chiefly from Basswood Lake, and other International waters	39,569	"
Sandy Lake	9,681	"
Total	1,059,628	"

PRODUCTION, BY SPECIES.

Of the total production of the state fisheries for ten months ending August 31, amounting to 1,059,628 pounds, nearly one-third, or 302,333 pounds, were pike-perch or wall-eyed pike. The greater portion of these have come from Red Lake, which is heavily stocked with this species.

Next in volume came mullets or suckers, most of which were taken in April and for which there was a good demand at a low price at the beginning of the run, but which soon fell off, leaving us with a surplus difficult to dispose of.

The pike, or the variety that we call pickerel and known to the trade in our country as jacks was third in volume, most of them having been taken by Indians with spears in winter through the ice. Peculiarly, Red Lake has produced very few pickerel. If they exist there they must be small and find their way through the pound net leads, as we do not get them.

One of our staple varieties and fourth in volume, is bullheads, for which we find a lively demand the year round. We have caught these in a limited region around Lake Winnibigoshish with small hoopnets and they are marketed skinned and dressed.

What we call a "sheepshead"—known farther south as the white perch—has never been regarded as a food fish to any extent in Minnesota, but we have induced our people to eat 58,000 pounds of them; they are now regularly displayed in the best markets in the Twin Cities at 7 cents a pound.

The white fish we have caught—some 58,000 pounds—have been taken incidentally in our pound nets or by Indians with gill nets. We have not encouraged taking them. Our Red Lake white fish are light colored, range from three to five pounds in weight and are of very fine quality.

We find in Red Lake great quantities of a species known locally as "goldeyes" and which is probably one of the mooneyes. These have been used as food but little in our locality until we began to urge their use on the ground of economy. We sell them at the same price as sheepshead, lake carp and mullets, and have disposed of 51,000 pounds of them.

Next, or eighth, come the tullibees or small mongrel whitefish of which we have great numbers in Minnesota. We sell them at about the same price as pickerel. They are obtained in quantities only in the fall..

The quillback or "lake carp" is not very plentiful in our waters, but sells better than sheepshead, goldeyes or mullets. The 45,000 pounds which were taken includes a considerable proportion of Asiatic carp of which we did not keep a separate record. It might be said in passing that most of the Asiatic carp and buffalofish produced in Minnesota are taken by regularly licensed fishermen and we send nearly four million pounds a year of them to New York.

In some of our northern lakes the yellow perch is very abundant and attains a good size—often a pound or more. The 10,000 pounds of perch taken, mostly came from Mille Lac Lake and were taken when pike-perch were being caught in gill nets.

One of the most despised fish with us is the burbot or "eelpout," but we have succeeded in inducing the people to eat over 7,000 pounds of them. Our men sometimes camouflaged them "northern catfish" which seemed to help some.

The balance of our catch has been made up of rock bass, sturgeon, catfish and dogfish, or bowfin, a small quantity of each. Peculiarly, we have been disappointed in Red Lake as a producer of sturgeon. The total production of fish by varieties for the period named has been as follows:

SIXTEEN VARIETIES.

Pike Perch	302,333	lbs.
Mullets	185,242	"
Pickerel	181,757	"
Bullheads	104,089	"
Sheepshead	58,875	"
Whitefish	58,855	"
Goldeyes	51,504	"
Tullibees	48,371	"
Carp	45,256	"
Perch	10,295	"
Burbot	7,678	"
Buffalofish	2,866	"
Rock bass	2,015	"
Sturgeon	390	"
Catfish	74	"
Dogfish	28	"
Total	1,059,628	"

HOW FISH ARE HANDLED.

Our pound net fish from Red Lake are packed round, with the exception of whitefish, which are always dressed. All other fish caught by Indian or white fishermen under contract for the state are required to be furnished dressed. They are required to be delivered at certain collecting stations where they are sorted, boxed, iced, (except in winter) and shipped and billed to customers. The standard boxes, holding about 150 pounds of iced fish are used, boxes to be returned by customers and used over again several times.

HOW DISTRIBUTED AND SOLD.

At first it was necessary to sell the fish in public markets, on the streets, in department stores, or anywhere to advertise the enterprise and acquaint the people with their opportunity to get cheap fish. Almost invariably the demand greatly exceeded the supply, as the people came in large numbers and bought eagerly of the state fish.

There has in some cases been a reluctance on the part of regular retail dealers to handle the state fish on account of the margin of profit and selling prices being fixed. We have sometimes found it necessary to sell the fish on depot platforms, in barber shops, general stores, private houses, and on the streets, until a demand was created and the regular dealer recognized the desirability of handling the state fish. In public market places and city department stores people fought for preferred positions in line to get fish. Game wardens, who acted as agents, often reported selling out shipments of several boxes in short order and the demand not satisfied. Volunteer dealers in many communities are still handling the fish, sometimes with no profit whatever to themselves, purely as a patriotic service.

Wholesale dealers have in some instances shown a disposition to co-operate, in others to object and obstruct. Finally they have all come to handle and distribute most of the fish sold in Minneapolis and St. Paul on a percentage basis, the price to retailer and consumer remaining the same as if sold direct by the state. Our plan is to ship by prepaid express to all points in the state. A large part of the distribution in southern Minnesota

is satisfactorily accomplished by shipping from Red Lake to St. Paul in refrigerator carload lots and distributing from there. This insures delivery of the fish fresh and wholesome in mid-summer.

The following quotation from a country newspaper describes a typical instance:

DOING HIS BIT.

"J. E. Madden, the local real estate man, has been doing a valuable service in the interest of food conservation which many people in this community are no doubt unaware of. Early last spring the State Game and Fish Commission employed help to seine fish in the big lakes in the northern part of the state, the fish to be used as a substitute for meat and sold at cost.

"The plan proved popular and has been continued ever since. Each week tons of fish are shipped to the larger cities of the state and disposed of in short order.

"The first box which came to Waseca was sent in care of Mr. Madden. He tried to get some local retailer to handle it, but none of them cared to. Mr. Madden did not propose to send the fish back so he placed the box on the walk in front of his office, dug up a scales and some wrapping paper, started a curbstone market and soon sold the fish to the people as they passed on the street.

"A box of fish arrived every week since and Mr. Madden has been right on the job as selling agent. But in this case he receives no commission or compensation for handling the fish, making change, remitting the money and other work incident to the job. Like war workers, he is doing his bit for the good of the cause. And in the meantime many a family in Waseca enjoys a fine mess of fresh fish each week at much less expense than the average cost of catching them."

It has not been practical in Minnesota to follow the admonition of the U. S. Food Administration to use the fish taken exclusively in the immediate vicinity of their production. We have found our opportunity in supplying those portions of the state which have no lakes or local fish from those other sections which abound in both. Where lakes abound, the people supply their own needs, but where there are no lakes the people have eagerly welcomed the opportunity we have given them to get fish. For some unaccountable reason there are scores of small towns in our state that never saw a fish on sale until they began to receive the state fish.

POPULARIZING COMMON FISHES.

Prior to the inauguration of the state fishing such common and lowly kinds of fishes as lake carp, sheepshead, mullets, and goldeyes (mooneyes) were seldom, if ever, seen in the better meat and fish markets of the cities and were wholly unknown in the smaller communities remote from lakes where they are produced.

By furnishing the fish in a fresh and wholesome condition and at low prices (retailing everywhere at not to exceed 7 cents a pound), and doing some advertising, we have built up a steady demand for the cheaper fishes in many places.

Little if any success has attended efforts to introduce smoked fish, nearly all our fish being bought and consumed fresh, but further efforts will be made in that direction, and the salting of certain varieties will be encouraged at times when plentiful. The U. S. Bureau of Fisheries has assisted in educational work by sending demonstrators to illustrate approved methods of smoking and curing coarse fish.

COMPARISON OF PRICES.

It has been the intention to keep the prcies as low as possible and pay for equipment needed and running expenses. It has been aimed also to maintain prices as nearly uniform as might be the year around. For instance the state has sold walleyed pike uniformly at 12 cents wholesale (retail 14 cents), while the same variety produced through regular channels has retailed at from 18 cents to 24 cents in the same markets. State whitefish have been retailed at 14 cents and 16 cents; other whitefish 22 cents to 30 cents, no better in quality. State pickerel have sold at 10 cents to 12 cents; other pickerel up to 18 cents. State bullheads retail at 14 cents dressed, others up to 18 cents. The state rough fish at 7 cents have been the only fish of the kinds in the markets.

NO INJURY TO LAKES.

By careful selection of localities for fishing and discrimination in choice of varieties taken, this great quantity of fish has been taken with little or no injury of any kind. In some cases those varieties which are used but little if at all by local people and consequently exist in abundance have been taken. In other instances a limited number of the better varieties have been taken where an abundance will permit. Some remote and little frequented lakes have been made to furnish a portion. It is apparent that Red Lake can give up a large volume of fish for a long time before any diminution will be noted, and the quality of some varieties will probably improve from year to year.

It would seem that it were safer and less apt to result in depletion, to carry on some of our commercial fishing by this method rather than by licensing commercial fishermen. More discrimination as to waters fished, varieties taken and in methods of fishing is possible, and the quantity taken at any time and place is absolutely under control. Unrestrained legal commercial fishing has all but exterminated our Lake Superior whitefish and Lake of the Woods sturgeon, and is rapidly coming to the same unfortunate result with the Lake Superior herring. There should be more state or government control of fishing with a view to conservation and our Minnesota State fishing may furnish suggestions as to more discretion and latitude in control of the industry.

BENEFIT TO THE PUBLIC.

The benefit to the people of the state and to the country has been unquestioned and apparent. Not only has a large quantity of fish at moderate prices been made constantly available, but they have been made use of, thus releasing a corresponding amount of meats and other foods for shipment and export. A distinct saving in cost has also resulted on account of the low price scale and much more fish have undoubtedly been used than would have been under ordinary conditions. The constant presence of low-priced state fish in the markets has also, without doubt, kept the prices of other fish at a lower average than would have been the case if there were no state fish to be had.

Direct evidence is not easy to get, but one instance was a letter received from a St. Paul woman expressing her appreciation of the opportunity to get cheap fish. With seven in the family and her husband employed as a janitor at $60.00 a month, rigid economy was imperative and state fish helped materially in her family to keep the larder supplied. Her case is undoubtedly typical of hundreds. Many expressions of appreciation have come from all parts of the state.

The enterprise has also served as an industry from which many settlers in remote parts of the State have added to their income. It has also served to put the business of the Indians of the Red Lake agency and elsewhere on a cash basis and has enabled them to invest liberally in Liberty Bonds and War Savings Stamps.

THE DEVELOPMENT OF MARKETS FOR NEGLECTED FISHES.

LEWIS RADCLIFFE,
United States Bureau of Fisheries.

It is a common practice in the commercial fisheries to centralize efforts on the development of means for catching and marketing increasingly larger supplies of the more highly prized fishes and to destroy or return to the water species of little or no market value. Some of the results of this practice are that the supply of some of the choice fishes has been greatly diminished, with the attendant possibility of ultimate exhaustion; predatory species of lesser value have been allowed to multiply and feed upon other more valued forms; the housewife has acquired an acquaintance with the merits of but a small number of species, and is encouraged to ask for these only, while millions of pounds of wholesome food fish are destroyed annually for lack of a market.

One of the important problems of the commercial fisheries of today is to create markets to absorb these millions of pounds of waste fish; to develop methods of preservation which will render them attractive to the consumer, and enable the fishermen to care for the surplus catch in seasons of abundance for use in periods of scarcity; to educate the public, not only to the merits of these species as food, but as to the best ways of preparing each for the table; and to provide for the utilization of the by-products. As in many fields of commercial enterprise, the waste product of yesterday has become the profit-producing product of today; so in the fisheries, the fishes which we destroy today may yield the profits of our tomorrow's work.

Upon entering this field, we should realize at the start that each species of fish, or each class, may call for special treatment; that each may present a distinct problem, varying from the simple to the very complex, and that in some cases tangible results will be attained quickly, while in others a large expenditure of time and effort will be required before the desired results are accomplished.

In some cases, the fish may possess sufficient merit and strike the popular fancy so quickly as to require only a little judicious

advertising. In other cases, the range of our activities will be much broader, but along usual commercial channels, including all phases, from the development of fishing grounds to arousing the interest of the consumer to purchase the product.

The campaign conducted by the Bureau of Fisheries to introduce the tilefish included all these phases. The summary of this work, contained in the Report of the Commissioner of Fisheries for 1916, is worthy of study here, and illustrates the effective manner in which the Federal Government can co-operate with the commercial interests in this field. "The fishing grounds were found and pointed out to the fishermen; a regular commercial fishing vessel was engaged to demonstrate the financial yield of this fishery under regular industrial conditions; the wholesale trade was enlisted in the distribution of the fish; the retailer was furnished with attractive display advertising matter, calling his customers' attention to the fact the fish was on sale; and the consumer was told about the tilefish and how to cook it, and his curiosity and interest was stimulated to the point where he wished to try it and asked his dealer for it."

The problem of creating markets for other species may prove even more intricate. In addition to the lines of development outlined above, it may be necessary to enlist the services of skilled technologists to solve problems of preparation and preservation of the fish for food, to determine by careful analysis the actual fitness for food and to develop methods of preparation of and uses for the by-products. It may even be necessary to overcome the aversion of fishermen to fishing for and bringing the fish to market, and to uproot deep-seated prejudice or actual repugnance on the part of the consumer to using them for food. We may be required to duplicate the work of the meat packing industry, of which it is said that commercial uses have been developed for every part of the hog but the squeal, and that even that is sometimes employed in phonograph records. On our ability, through extended research and a campaign of education to develop such uses and markets for all parts of these neglected fishes, may depend the margin of profit necessary to support the fishery.

As the development of fisheries and uses for sharks presents such a problem, it will serve as an illustration. In this campaign, it has been necessary to:

(1) Devise apparatus suitable for catching sharks in commercial quantities;

(2) Assemble available data as to places where and seasons of the year in which sharks can be taken commercially;

(3) Instruct the fishermen in the methods of extracting the liver oil and place them in touch with markets for it;

(4) Create markets for the hides and develop methods of removing them economically, salting and boxing them in a manner acceptable to the trade;

(5) Determine the actual fitness of the flesh of certain species for human consumption;

(6) Develop methods of stabilizing and deodorizing the liver oil with the object of using it for edible purposes, and analyze it to determine its fitness for food;

(7) Work out satisfactory methods of pickling, smoking or kippering, drying, dry-salting and canning the flesh;

(8) Conduct investigations to overcome special difficulties encountered in preserving the product;

(9) Carry on cooking experiments to determine the best methods of preparing the fresh and preserved products for the table;

(10) Overcome the objections of the fishermen to engaging in the fishery;

(11) Enlist the co-operation of the wholesale trade in distributing the fish;

(12) Aid the retailer to dispose of the fish, and furnish him with advertising matter to attract the consumers' attention.

(13) Conduct a campaign of education among the consumers to uproot their prejudices against the product and to enlist their interest in the merits of it to the point where they will buy it of their dealers;

(14) Lend encouragement to the establishment of fisheries and the installation of equipment necessary to render the by-products, that otherwise might be wasted, marketable;

(15) Encourage the conversion of waste into fish meal or scrap, and the flesh also where it is impracticable to market it for food.

As some of these individual lines of development present problems of considerable magnitude, with numerous ramifications, several of them will be discussed in greater detail.

Hides. In attempting to create markets for the hides, it was first necessary to assemble a supply of raw skins and distribute them among tanners and others desirous of ascertaining their fitness for special uses. By so doing, a large number of persons were interested to experiment with these skins.

In many cases, tanners found that their methods were unsuited to these products and some of them, therefore, assumed that good leathers could not be produced. In other cases, some success was attained, and such tanners were encouraged to continue their experiments, with the result that they have evolved satisfactory methods of tanning these hides into leathers suitable for making shoes, bags, etc., and have become interested in the development of the industry.

In the course of this work in tanning and finishing the hides, one of the principal difficulties met with was the problem of removing the shagreen, composed of minute horny denticles. Some attempted to remove this before the hides were tanned, others after tanning. The latter has been the more satisfactory.

After the hides are tanned, neutralized, dyed, rendered pliable and drained, they are given a coat of paraffin and oil, tacked and dried slowly. They are then smooth-plated and shaved on the grain side to remove the coarsest part of the grain or denticles. The hide is then gone over lightly on a rapdily revolving carborundum wheel, when it is ready for finishing. Tanners were also interested to test the hides of the different species of sharks to determine whether differences in quality exist, and the fitness of each for special uses.

Having aroused the interest of the tanners, it then became necessary to develop methods for skinning the sharks, pickling and boxing them in a manner acceptable to the trade, to supply the fishermen with this information and encourage them to save the hides. Here again difficulties arose. Unlike mammal hides, in which the flesh and hide are held together by a thin layer of connecting tissue, shark skins are firmly joined to the flesh by tough septa extending into the flesh, which have to be severed with the knife. As a result, the task of skinning sharks, particularly those of large size, was a laborious, time-consuming one, threatening to make the undertaking unprofitable. Steps have been undertaken to overcome this difficulty, and, of one device that has been

perfected, it is claimed that by its use the hide can be removed in four minutes, as compared with from one to two hours by hand.

With the accomplishment of satisfactory progress in these fields, it was necessary to make various tests as to tensile strength, wearing qualities, etc., to determine the uses to which such leathers are best suited, and to call to the attention of manufacturers of leather goods such qualities of excellence as these leathers possess, that they may be interested to purchase available supplies. As a matter of passing interest, it may be mentioned that the average tensile strength per square inch of three tanned hides was 3,479; 3,905; and 4,742 pounds respectively.

Oils. With the increased demand for and advance in price of edible oils and fats, interest has been aroused in the possibilities of rendering fish oils suitable for edible purposes. This has already been accomplished in the case of whale fat. In 1914, Denmark used 20,000 barrels of hardened whale fat in the margarin industry, and it is reported to be well suited for making margarin that keeps well and tastes well, and to be even better suited for making lard.

Processes of hydrogenation have been evolved, which, it is claimed, will render fish oil suitable for edible purposes. Our responsibility does not end here. For example, one technologist has discovered the presence of a large percentage of hydrocarbon oil in the liver oil of some sharks. In such cases, the oil may be unsuitable for food purposes. It is important that information of this character be ascertained and made available.

As hydrogenation is usually accomplished by the use of a metal catalyist such as nickel, presence of traces of which may render the oil unsuitable for food, it is important that care be exercised to avoid this contingency, or methods developed which do not require the use of such metals. In addition, hydrogenation should not be carried so far as to raise the melting point of the fats above 98.6° F., the temperature of the body, as otherwise they are not liquefied in the body.

Preservation. In developing satisfactory methods of preserving the flesh, difficulties have been encountered, some of which may require extended research and experiment before they are overcome. For example, the flesh contains small quantities of urea, a substance of itself practically harmless. By various methods, the urea may be converted into ammonia, which in

itself is harmless, but, on account of its odor, gives the impression that the product is spoiled, unfit for food. We have learned by experiment that in pickle the urea slowly dissolves out, uniting with the salt in the brine, thus tending to eradicate this objectionable feature. Little or no trouble has been experienced with the flesh which has been pickled and smoked or kippered, and the canned, kippered fish is very attractive indeed.

To some, it may appear that the writer has wandered afield in this discussion, has laid undue stress on the difficulties which have to be met. This has been done purposely, with the hope of bringing about a more complete appreciation of the varied character of the problems and the way in which they may be met.

It is to be feared that some may be discouraged by the magnitude of the task which confronts them in developing markets for these neglected fishes. However, by concerted effort on the part of those engaged in the fisheries, state and federal agencies and skilled technological investigators, it can be done. In fact, much has already been accomplished. By way of illustration, it is estimated that on the basis of the weight of the fresh fish, the following quantities of certain of these neglected fishes were marketed during 1917: burbot, 500,000 pounds; grayfish, 4,000,000 pounds; sablefish, 4,000,000 pounds; Alaska Scotch-cured herring, 2,000,000 pounds; tilefish, 6,000,000 pounds; and whiting, 20,000,000 pounds. As yet, no estimates are available as to the results of the campaign in introducing drumfish, eulachon, menhaden, sharks, fish roe and buckroe, etc. The markets absorbed these 35 millions or more pounds of fish in a single year and will absorb increasingly larger quantities. For every time that we create a place in the market for one of these new fishes, we weaken the consumers' objections to trying new fishes.

Is not this question of marketing the neglected fishes one of the big problems of the commercial fisheries of today, and is it not worthy of our concerted effort to continue the development of such fisheries, observing proper safeguards to prevent depletion, until we have no more waste than in other highly organized industries? My answer is in the affirmative.

PRODUCTS OF THE COMMERCIAL FISHERIES OF THE UNITED STATES.

By John N. Cobb.

The heavy drain upon the ordinary food resources of the world, as a result of the devastation wrought throughout the countries of Europe by the warring armies, and the reduction in producing power through this and the drafting of the erstwhile tillers of the soil into these fighting armies, has focused attention upon the denizens of the fresh and salt waters of the world as a source from whence the shortage caused by the above factors may be partly, if not wholly, met. The U. S. Bureau of Fisheries, ably seconded by various state fish commissions, and public and private organizations, firms and individuals, has done excellent work in creating new and extending old markets for fishery products, and also in creating a demand for hitherto neglected aquatic products.

Owing to its extremely favorable situation, with the Atlantic on its eastern and southeastern side, the Pacific on the west and the Great Lakes on the north, with its interior covered with a network of rivers, some of them amongst the largest in the world, while thousands upon thousands of big and little lakes dot the country, the commercial fisheries of the United States have been extremely important and valuable from early times. For a number of years they have surpassed those of any other country in both extent and value, and this superiority has been more than maintained since the great drive upon the fisheries began three years ago.

As a result of the lack of a central body collecting annual statistics of our fisheries (Congress has never provided the U. S. Bureau of Fisheries with sufficient money and personnel to make possible a thorough statistical canvass of all our fisheries each year), it is not an easy matter to arrive at the proper quantity and value of the same. Where available, and of sufficiently late date, data collected by the U. S. Bureau of Fisheries have been used. A few states collect fairly accurate statistical data annually and these have been used in such cases, while by correspondence and in various other ways the author has collected much valuable data

which have been incorporated in the table shown herewith. Great conservatism has been used in collecting and handling the data, with the result that it undoubtedly understates rather than overstates the actual production.

No account has been taken of the enormous quantity, in the aggregate, of fishery products caught and consumed annually by sportsmen and semi-professional fishermen. In Alaska, it is estimated, on very reliable information, that the natives alone catch and consume some 30,000,000 pounds of fish, none of which appears in the above table, and the same is true to a much less extent in a number of other states.

The table below shows the production by states under three headings. "Fishes proper" include all those used for food. "Other edible products" include the meats of mollusks, crustaceans, etc., while "Non-edible products" comprise fishes (such as menhaden) used solely for fertilizer and oil, shells, skins of aquatic animals, kelp, seaweed, etc., The products are shown just as landed by the fishermen, and the value is that received by him for the same. Large quantities of products landed are either canned, salted, mild-cured, smoked, or otherwise prepared, which work gives employment to many thousands of persons, and consumes millions of dollars' worth of tinplate, box shooks, barrels, salt, oil, and the thousand and one things needed in the preparation of secondary products, all these vastly increasing the value of the goods. In 1917 the canned salmon produced in Alaska alone sold for about $45,000,000, but in the table only the value of the raw fish has been shown.

PRODUCTS, BY STATES, OF THE COMMERCIAL FISHERIES OF THE UNITED STATES.

States	Fishes		Other Edible Products		Non-Edible Products		Total Products*		Total Products in 1908†	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Alabama	7,178,700	$ 269,600	3,359,819	$ 79,484	.....	.....	10,538,519	$ 349,084	10,665,000	$ 387,000
Alaska	460,301,646	7,770,532	97,319	7,186	8,395,664	$ 635,995	468,794,629	8,413,713	229,194,603	3,300,751
Arizona	80.000	6,400	.....	.....	.....	.....	80.000	6,400	.....	.....
Arkansas	4,475,100	133,200	33,000	4,100	8,060,050	70,100	12,568,150	207,400	12,567,000	207,000
California	178,450,472	5,353,514	23,757,782	2,138,190	797,812,174	205,894	1,000,020,428	7,697,598	47,477,000	1,970,000
Colorado	1,360,166	185,493	.....	.....	.....	.....	1,360,166	185,493	.....	.....
Connecticut	65,055,070	593,837	29,201,635	2,048,761	95,592 810	389 419	189 849,515	3,032,017	66,942,000	2,982,000
Delaware	5,278.200	208,100	3,759,996	243,617	66,854,830	274,476	75,893.026	726,193	70,769.000	541,000
Florida	61,548,640	2,361,093	14,621,629	422,580	4,330,444	636,416	80 500,713	3,420,089	74,087,000	3.389,000
Georgia	4,505,800	344,000	7,993,579	275,683	700	3,600	12,500.079	623,283	14,828,000	701,000
Idaho	1,640,000	220,000	.....	.....	.....	.....	1,640.000	220,000	.....	.....
Illinois	40,363,454	1,280,187	.....	.....	14,926.000	338,398	55,289,454	1.618,585	74,620,000	1,436,000
Indiana	1,076,900	67,950	.....	.....	18.488,000	251,343	19.564,900	319,293	15,507,000	223,000
Iowa	5,222,493	228,089	95,500	2,900	4,700,500	45,600	10,018,493	276,589	8,867,000	215,000
Kansas	432,000	28,000	.....	.....	157.000	2,356	589,000	30,356	432,000	28,000
Kentucky	1,975,100	90.100	1,900	90	3,413,000	18,000	5,390,000	108,190	5,390,000	110,000
Louisiana	11,093,400	428,800	50,382,700	1,322,178	350,500	126 700	61,826,600	1,877,678	46,160,000	1,569,000
Maine	263,231,482	4,892,686	39,314,587	2,847,541	44,910	2,420	302,590,979	7,742,647	173,843,000	3.257,000
Maryland	65,057,784	724,118	58,974,535	2,468,715	15,621,911	105,058	139 654,230	3,297,891	113,796,000	3,306,000
Massachusetts	201,973,031	6,434,259	10,018,190	1,210,697	4,239,000	347,800	216,230,221	7,992,756	244,313,000	7,095,000
Michigan	29,251,327	1,469,615	.....	.....	923,000	26,613	30,174,327	1,496,228	38,302,000	1,473,000
Minnesota	32,601,679	1,394,147	687,500	275,;00	2,144.000	53,115	35,433,179	1,722.262	7,475,000	192,000
Mississippi	8,520,600	163,500	14,075,340	325,502	.....	.....	22,595,940	489,002	20,547,000	556,000
Missouri	6.478,900	242,800	91,900	11,500	212.200	18,230	6,783,000	272,530	6,751,000	271,000
Montana	110.000	6,000	.....	.....	.....	.....	110,000	6.000	.....	.....
Nebraska	399,000	22,000	.....	.....	55,000	610	454.000	22,610	399.000	22,000
Nevada	107,536	12,834	.....	.....	.....	.....	107,536	12,834	.....	.....
New Hampshire	642,000	51,600	336,710	109,960	.....	.....	978,710	161,560	677,000	53,000
New Jersey	51,663,426	1,497,592	19,748,819	1,298,770	22,277,610	62,644	93,689,855	2,859,006	74,827,000	3,069,000
New Mexico	70,000	4,900	.....	.....	.....	.....	70,000	4,900	.....	.....
New York	14,872,296	1,605,560	39,173,444	3,879,281	95,221,710	352,619	149,267,450	5.837,460	76,485,000	4.594,000
North Carolina	38,283,700	1,731,900	4,880,144	279,428	47,593,110	125,300	90,756,954	2,136,628	101,422,000	1,776,000
North Dakota	100,000	7,000	.....	.....	.....	.....	100,000	7,000	.....	.....
Ohio	31,016,159	1,614,478	.....	.....	50,000	1,236	31,066,159	1,615,714	28,917,000	840,000
Oklahoma	86,700	4,300	.....	.....	.....	.....	86,700	4,300	6,700	300
Oregon	35,207,424	1,518,326	700,199	49,268	.....	.....	35,907,623	1,567,594	28,217,000	1,356,000
Pennsylvania	13,147,367	582,100	738,878	56,225	.....	.....	13,886,245	638,325	11 888,000	513,000
Rhode Island	34,767.000	695,100	18,191,002	1,656,961	.....	.....	52,958,002	2,352,061	44.254,000	1,752,000
South Carolina	2,988,600	140,200	5,152,768	106,677	100	75	8,141 468	246,952	14,104,000	288,000
South Dakota	70,000	4,200	.....	.....	260,000	4,198	330,000	8,398	70,000	4,200
Tennessee	2,329,300	97,200	6,700	1,200	.....	.....	2,336,000	98,400	4,506,000	112,000
Texas	8,864,671	380,453	2,601,999	156,888	7,070	1,450	11,473,740	538,791	10,439,000	446,000
Utah	1,481,863	67,458	.....	.....	.....	.....	1,481,863	67,458	.....	.....
Vermont	678,682	45,069	.....	.....	.....	.....	678,682	45,069	.....	.....
Virginia	128,102,295	1,333,342	75,551,968	3,334,991	291,305,099	1,012,682	494,959,362	5,681.015	312,515.000	4,716,000
Washington	145,303,549	5,970.679	3,426,439	541,384	4,383,125	141,632	153,113,113	6,653,695	100,456,000	3,513,000
West Virginia	33,000	2,000	.....	.....	.....	.....	33,000	2.000	33,000	2,000
Wisconsin	24,691,448	871,015	438,181	9,212	6,304,000	153,672	31,433,629	1,033,899	30,953,000	1,067,000
Wyoming	230,000	13,800	.....	.....	.....	.....	230,000	13 800	.....	.....
Hawaii	6,556,217	635,366	416,518	42,531	.....	.....	6.972,735	677,897	6,972,735	677,897
Total	1,998,954,177	53,604,492	427,830,680	25,206,500	1,513,723,517	5,407,651	3,940,508,374	84,418,643	2,129,621,338	58,009,648

* Made up from data for the latest periods available.

† With the exception of Alaska and Hawaii this data is from the published results of the combined U. S. Census and Fisheries Bureaus investigations for the year 1908.

PER CAPITA CONSUMPTION.

Much interest has been exhibited in the per capita consumption of fish in the United States. We are heavy importers and exporters of fishery products. During the fiscal year ended June 30, 1917, we imported 320,876,663 pounds, valued at $22,635,983, while during the same period we exported 183,355,571 pounds of domestic products, valued at $19,875,614, and 6,529,627 pounds of foreign products, valued at $655,034, a total of 189,885,198 pounds exported, valued at $20,530,648, leaving the net quantity of imports over exports at 130,991,465 pounds and $2,105,335. The total production of edible products in our commercial fisheries amount to 2,426,784,857 pounds, to which should be added 130,991,465 pounds, representing the net imports, making a total of 2,557,776,322 pounds consumed in this country. Estimating the population of the United States (including Alaska and Hawaii) at 100,000,000, this would show a consumption of 25.57 pounds each year by every man, woman and child.

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Division of Fishes,
U. S. National Museum

Vol. XLVIII No. 2

TRANSACTIONS

OF THE

AMERICAN FISHERIES SOCIETY

Smithsonian Institution,
National Museum.

MARCH, 1919

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Organized 1870 Incorporated 1910

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TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

VOLUME XLVIII NUMBER 2

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PROCEEEDINGS

of the

Forty-Eighth Annual Meeting

of the

American Fisheries Society

NEW YORK CITY

September 9, 10 and 11, 1918

Opening Session, Morning, September 9, 1918.

The Forty-eighth Annual Meeting of the American Fisheries Society was convened in New York City, in the Waldorf-Astoria Hotel, on the morning of September 9, 1918. Mr. Henry O'Malley, the President of the Society, presided throughout the various sessions.

The members present were requested to register. Fifty-four members were present at the opening session and twenty-six registered later, making a total of eighty-one members present during the meeting. Twenty-four States, the District of Columbia, Canada and China were represented.

President O'Malley appointed the following Committees:

Committee on Nominations: Messrs. Henry B. Ward, Geo. H. Graham, A. H. Dinsmore, Eben W. Cobb and S. M. Cowden.

Committee on Time and Place of Meeting: Messrs. John P. Woods, T. Roualt, Geo. D. Pratt, Grant E. Winchester and John M. Crampton.

Program Committee: Geo. C. Embody, Adrian Thomas and Carlos Avery.

Auditing Committee: Messrs. John P. Woods, Geo. H. Graham and Jas. Nevin.

Committee on Resolutions: Messrs. M. L. Alexander, A. J. Crandall and John R. Woods.

Committee on Awards: Messrs. John W. Titcomb, Henry B. Ward, G. E. Jennings, A. L. Millett, J. G. Needham and G. C. Leach.

The Secretary, Mr. John W. Titcomb, presented the names of applicants for membership, who were then admitted by vote of the Society. The names of these new members have already been published as an appendix to the List of Members, TRANSACTIONS, Sept., 1918, p. 135).

Mr. A. L. Millett, Treasurer of the Society, reported that he had attended the annual meeting of the Canadian Fisheries Society at Halifax, a couple of weeks previously, and that he was much impressed with the fine character of the meeting and the high quality of the program. He brought with him the greetings and best wishes of the Canadian Society.

Following a number of announcements by the Secretary, the meeting adjourned early in order to allow the various committees ample time for their work.

Monday Afternoon Session, September 9th.

The Session was devoted to the reading and discussion of papers.

Results of Some Trout Feeding Experiments carried on in the Experimental Hatching Station of Cornell University.

BY DR. GEO. C. EMBODY.

This paper, which was given first place in competition among the papers on fish culture, has already been published (TRANSACTIONS, Dec., 1918, p. 26).

Discussion.

In the discussion which followed the reading, Professor Embody replied to a number of brief questions, explaining that the temperature (Fahrenheit) ranged from about 65° down to about 37°. In most of the experiments the

temperature ranged from 55° to 65°. The experiments were made at all times of the year, but most of them were made during the summer months. Ordinary pure spring water was used, without filtration, as it came directly from a spring.

Mr. Jas. Nevin, of Wisconsin: We have found horse meat much superior to any other for our brook trout. At one hatchery we are using sheep liver and find it very good food, provided that Red Dog Flour is boiled and mixed with it. But I find that the greatest success in fish culture is in connection with the water. In some of our hatcheries we have success with some kinds of fishes and not with others. We have one hatchery where we will run about sixty-five per cent of losses with pike-perch eggs, while in another we hatch 90% to 95% of them.

Mr. John W. Titcomb, of New York: Dr. Embody's paper is a most valuable and timely contribution, because the cost of food in these days is a very serious one. In addition to the cost value of the fish foods, Dr. Embody's experiments have in mind the effect upon the quality of the flesh, which is very important, but in the production of fingerlings for distribution the food that will produce results at minimum cost, taking into consideration both labor and material, is the one which will be most generally adopted. Assuming that the fish which are planted as fingerlings will thereafter depend entirely upon natural food, the quality of the flesh will be adjusted by the time the fish have grown to edible size.

Since knowledge of negative results of experiments may prevent waste of energy through repetition, I will briefly review some experiments at the State Fish Hatchery at Caledonia, New York.

The experiments were under the immediate supervision of Mr. Thomas Chamberlain, a student of Dr. Embody, operating under my direction. One of the objects of the experiments was to apply in a practical manner, in regulation rearing ponds, the knowledge obtained from the experiments in the small and limited number of rearing boxes available at Cornell University and to supplement them with other experiments suggested by hatching customs and conditions.

The experiments were terminated rather abruptly when Mr. Chamberlain was drafted into the army, where he is now patriotically serving his country "over there."

For some of the experiments concrete rearing pools 3 feet by 36 feet to the number of ten were utilized. For other experiments, hatching troughs 14 inches by 12 feet were used. The species fed under observation consisted of brook trout, lake trout and rainbow trout and the following tables give the results. (The tables are a condensation of a portion of Mr. Titcomb's remarks).

TABLE No, 1.

October 27, 1917—February 7, 1918. (Period of 103 days, minus 7.*)	RAINBOW TROUT YEARLINGS.				
Food used	75% melts 25% meat meal	75% lungs 25% meat meal	75% liver 25% meat meal	50% lungs 50% melts	50% liver 50% melts
Size of basin	36′x3′x10″	36′x3′x10″	36′x3′x10″	36′x3′x10″	36′x3′x10″
Number of fish:					
Beginning of period	406	406	406	406	406
End of period	406	406	404	405	405
Total mortality	0	0	2	1	1
Total weight of fish:					
Beginning of period	30 lb., 7 oz.	34 lb., 3 oz.	31 lb., 7 oz.	36 lb., 1 oz.	32 lb., 4 oz.
End of period	46 lb., 3 oz.	39 lb.,12 oz.	49 lb., 9 oz.	36 lb.,10 oz.	42 lb., 4 oz.
Total gain or loss	15 lb.,12 oz.	5 lb., 9 oz.	18 lb., 2 oz.	9 oz.	10 lb.
Average individual weight:					
Beginning of period	1.199 oz.	1.347 oz.	1.238 oz.	1.421 oz.	1.271 oz.
End of period	1.820 oz.	1.559 oz.	1 938 oz.	1.447 oz.	1.694 oz.
Average individual gain or loss	.621 oz.	.212 oz.	.700 oz.	.026 oz.	.423 oz.
Approximate average water temp	44.75° F.	44.75° F.	44.75° F.	44.75° F.	44.75° F.
Weight of food daily consumed	First perio	d, 1 lb.			
	Second and	third perio	ds, 10 oz.		
Total weight of food consumed	68 lb.,10 oz.	68 lb.,10 oz.	68 lb.,10 oz.	68 lb.,10 oz.	68 lb.,10 oz.
Average food consumed per individual	3.197 oz.	3.197 oz.	3.205 oz.	3.201 oz.	3.201 oz.
Average number of individuals	406	406	405	405.5	405.5
Total efficiency factor = $\frac{\text{total gain}}{\text{total consumption}}$	.229	.081	.262	.008	.145
Individual efficiency factor = $\frac{\text{average individual gain}}{\text{average individual consumption}}$	.194	.166	.218	.009	.132
Cost per pound of food	$.0425	$.0725	$.095	$.06	$.075
Cost per pound of increased weight of fish	$.185	$.887	$.351	$.732	$.515

* On four days no meat received at hatchery. On three days it was impossible for Mr. Chamberlain to make observation.

TABLE No. 2

Period of 14 Days. Oct. 25—Nov. 8, 1917.	Lake Trout Fing.		Brook Trout Fing.		Rainbow Trout Fing.	
Food used	75% milk 25% meat meal	50% liver 50% melts	75% milk 25% meat meal	50% liver 50% melts	75% milk 25% meat meal	50% liver 50% melts
Size of basin	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″
Number of fish:						
Beginning of period	2,206	2,354	749	609	979	949
End of period	2,182	2,344	718	608	979	949
Total mortality	24	10	31	1	0	0
Per cent mortality	1.09%	.42%	4.32%	.16%	0	0
Total weight of fish:						
Beginning of period	13 lb., 1 oz.	16 lb., 7 oz.	5 lb.,8.5 oz.	5 lb.,11 oz.	4 lb., 9 oz.	4 lb., 9 oz.
End of period	12 lb.,11.5oz	17 lb.,13 oz.	6 lb.,6.5 oz.	6 lb.,12 oz.	5 lb., 2.5 oz.	5 lb., 4 oz.
Average individual weight:						
Beginning of period	.094 oz.	.112 oz.	.118 oz.	.149 oz.	.074 oz.	.079 oz.
End of period	.093 oz.	.121 oz.	.143 oz.	.177 oz.	.084 oz.	.089 oz.
Av. individual gain or loss	—.001 oz.	.008 oz.	.025 oz.	.028 oz.	.010 oz.	.010 oz.
Approximate average water temp	47° F.	=ditto	=ditto	=ditto	=ditto	=ditto
Wt. of food daily consumed	11 lb., 4 oz.	11 lb., 4 oz.	10 oz.	10 oz.	10 oz.	10 oz.
Wt. of total food consumed	171 lb.,8 oz.	171 lb.,8 oz.	81 lb.,12 oz.	81 lb.,12 oz.	81 lb.,12 oz.	81 lb.,12 oz.
Average food consumed per individual	.128 oz.	.119 oz.	.190 oz.	.230 oz.	.145 oz.	.148 oz.
Av. number of individuals	2,194	2,349	733.5	608.5	979	949
Total efficiency factor= total gain / total consumption	—.020	.079	.100	.121	.069	.079
Individual efficiency factor= average individual gain / average individual consumption	—.078	.075	.132	.122	.068	.068
Cost per pound of food	$.05	$.0725	$.05	$.0725	$.05	$.0725
Cost of each pound of increased weight of fish	.....	$.92	$.50	$.60	$.74	$.63

TABLE No. 3

Nov. 8—Nov. 28, 1917. (Period of 20 days).	Lake Trout Fing.		Brook Trout Fing.		Rainbow Trout Fing.	
Food used	75% milk 25% meat meal	50% melts 50% liver	75% milk 25% meat meal	50% melts 50% liver	75% milk 25% meat meal	50% melts 50% liver
Size of basin	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″	12′x3′x10″
Number of fish:						
Beginning of period	2,182	2,344	718	608	979	949
End of period	2,166	2,340	671	603	979	949
Total mortality	16	4	47	5	0	0
Total weight of fish:						
Beginning of period	12 lb.11.5 oz.	17 lb.,13 oz.	6 lb.,6.5 oz.	6 lb.,12 oz.	5 lb.,2.5 oz.	5 lb., 4 oz.
End of period	14 lb.,5.5 oz	19 lb.14.5 oz.	61 lb.,11 oz.	81 lb.,10 oz.	5 lb., 6.5 oz.	5 lb.,14.5 oz
Total gain or loss	1 lb.,10 oz.	2 lb., 1.5 oz.	5.5 oz.	1 lb., 14 oz.	4 oz.	10.5 oz.
Average individual weight:						
Beginning of period	.093 oz.	.121 oz.	.143 oz.	.177 oz.	.084 oz.	.089 oz.
End of period	.106 oz.	.148 oz.	.159 oz.	.228 oz.	.088 oz.	.099 oz.
Av. individual gain or loss	.013 oz.	.027 oz.	.016 oz.	.051 oz.	.004 oz.	.010 oz.
Approximate average water temperature	46° F.	=ditto	=ditto	=ditto	=ditto	=ditto
Wt. of food consumed daily	1 lb., 4 oz.	1 lb., 4 oz.	10 oz.	10 oz.	10 oz.	10 oz.
Total food consumed	25 lb.	25 lb.	12 lb., 8 oz.	12 lb., 8 oz.	12 lb., 8 oz.	12 lb., 8 oz.
Average food consumed per individual	.184 oz.	.170 oz.	.289 oz.	.330 oz.	.204 oz.	.211 oz.
Av. number of individuals	2,174	2,342	694.5	605.5	979	949
Total efficiency factor= Total gain / Total consumption	.065	.084	.028	.150	.020	.053
Individual efficiency factor= Average individual gain / Average individual consumption	.071	.159	.055	.155	.019	.047
Cost per pound of food	$.05	$.075	$.05	$.075	$.05	$.075
Cost per pound of increased weight of fish	$.769	$.89	$1.81	$.50	$2.50	$1.43

It will be seen that milk thickened with rennet or junket proved of no value as a fish food, notwithstanding the fact that Dr. Embody, in earlier experiments, had succeeded in rearing to fingerlings some rainbow trout fed entirely upon thickened skim milk. The milk experiment had in contemplation the use of a by-product from the creameries. While the results of the milk experiment at Caledonia are regarded as final, the success in another water supply confirms some views I have entertained that an artificial fish food which is entirely satisfactory in water from one source of supply may be quite the reverse in water from another source. It suggests some ramifications of this subject too extensive for discussion now.

These are crude experiments. We did not weigh all of the fish in each instance, but we took a certain number of fish each time at random instead of taking the total number under observation, which would be rather difficult in an experiment on so large a scale. I hope Dr. Embody will continue this work. I think it means a great deal.

Now may I talk on the general subject of fish food, because perhaps some of the suggestions will help others? The war just about doubled the cost of fish food, as you know, and we had to resort to every possible makeshift to raise fingerlings in increased numbers and still keep within a legislative appropriation based upon pre-war prices. Where we were using beef liver we changed to pig liver or to melts—very largely to melts. At the Chautauqua Hatchery, where we operated nets for taking the muscallunge and kept the nets set for removing the bill fish or gar pike, we caught a great many carp. The foreman raised some beautiful four inch fingerling trout by feeding carp. The fish were about one and a half inches in length when Mr. Winchester began feeding them carp. Foreman Winchester's recipe for preparing the carp and suckers for fish food is as follows:

"Hang them up, hooked in the mouth; cut around gills, down the back, and on each side of the stomach. Pull the skin off with pincers. Then strip the meat off the backbone and ribs and run it through The Enterprise meat chopper."

Near the Adirondack Hatchery there are lakes containing yellow perch which, during the summer months, are grubby and the people don't care for them. To get them out of the lake is a good thing. Foreman Otis caught grubby yellow perch and fed them to the fingerling trout, and it proved to be a very desirable food. The perch are skinned and then ground up in a meat chopper, guts and all. At the Fulton Chain Hatchery a good many suckers were used to feed the trout, after preparing them in a similar manner. These perch and suckers are not of much value in the summer time as human food. One might argue that carp is a human food, and I will confess to you that if we had to buy the carp at 12 cents a pound, which is the wholesale price, and then allow for the waste, it would be a very expensive food, but the carp are undesirable in the lake where caught.

Another year it is proposed to "beat the devil around the stump" by letting some of the carp go to human consumption as war food, and arrange with the man who markets them to furnish us liver or melts in exchange,

but I want to say that as far as my experience has gone it is a mighty good thing to use fish to some extent as fish food. With a part fish diet you get a better quality of fish and a stronger fish than if you feed entirely on liver and melts.

Mr. G. C. Leach, of the U. S. Bureau of Fisheries: I notice nothing has been said in the discussions about beef heart. In the middle west, beef heart usually sells for twenty to thirty per cent cheaper than beef liver, and it has been considered that in protein content it is fifty per cent greater than beef liver. In making up contracts with the packing houses, if it is specified that they must trim the beef liver of all gristle and fat, the fish culturist does not have much to eliminate, and that part that he does have to cut out can be fed to the adult fish. All the better portion of it can be passed through the meat grinder several times, using a very fine plate, and fed to the fry. I have found that it is preferable to the beef liver, because the liver, when ground very fine, disintegrates into a liquid and a fibrous substance, either of which may cause mortality in the trout. The beef heart grinds in very fine particles and the fry get something that does them some good; so, for that reason, out in the middle west we have been feeding beef heart when we could get it, and it has always given very good satisfaction.

In the middle west, also, we feed to our larger fish various gross fish, such as the gissard shad, and cat-fish, perhaps a little off the mark, and purchased for about six cents a pound. That diet is very good for adult fish, but when ground through the smaller plates it disintegrates and I doubt if it is very good for small fish unless fed with some carbo-hydrate. But for the larger fish I believe it produces a better egg and is more of a natural fish food, especially for trout.

Professor E. E. Prince, of Ottawa, Canada: I think it is desirable in selecting food always to look at the character of the natural food of the fish. The trout are great insect feeders in the fresh water, and anything that corresponds to the physical character of this insect food ought to be good. Ground up shrimps of course would correspond to the food they get in the salt water. Fish itself would correspond to the various species of fish on which trout and salmon no doubt live to some extent in fresh water, but I have always felt that the large internal organs of mammals, like liver, lungs, etc., do not quite correspond to anything in the natural food of these fish, and therefore it would be wise to combine other elements with this ground lung and liver in order to provide a concentrated food.

There is no doubt that fish fed with very concentrated food are apt to have digestive troubles. The digestive canal is prepared to deal with a certain amount of waste, and if there is no waste to the food, indigestion is apt to occur. Consequently, it is a good thing to put in more fresh material along with the fish, or shrimp powder, or whatever it may be, in order to give the intestines some work to do.

You may have noticed in the Canadian reports that coarse fish ground up was used, years ago, for feeding the young fingerling salmon, and it was

a great success. The ground up meat of these suckers and inferior fish is not cooked. I have sometimes thought the cooking of meats changed them to such an extent that perhaps it made a difficulty in digestion for young fish. If we could provide them with materials which are uncooked, perhaps we may have better results. A good food must have waste materials in it in order to avoid digestive troubles.

I look forward with much interest to the further work which Dr. Embody promises to carry on, because I feel this is one of the fields in which very valuable results are to be achieved, and I should like to hear what the results of using fish roes, ground shrimps, etc., may be, where those are obtainable.

Mr. Geo. H. Graham, of Massachusetts: During the past two years there has been more fault found with eggs that come from the commercial hatcheries because of infertility or the young fish dying soon after hatching, it seems to me, than any period I have ever heard of. Some of the largest commercial hatcheries have been putting out bad eggs, which show very poor success at the different hatcheries, and we also know that during the past two years some of the commercial hatcheries have had a great mortality among the young fish. Now is it not possible that this trouble may all be due to the fact they have been feeding the wrong stuff? If they are feeding fish entirely to their adult trout, we may suppose that those fish are not capable of producing eggs with any vitality to them, and it would seem to me that if Dr. Embody could find out what they have been feeding in the last two years to their adult fish, it might give him some clue as to what not to feed. Of course, they have been doing this on account of the high cost of liver, which they have previously fed, and in trying to obtain a substitute they have possibly been using the wrong food.

Mr. G. C. Leach: I would like to ask Dr. Embody why he eliminated beef heart in his experiments, and if he expects to do anything with regard to that in the future?

Dr. Embody: We have not eliminated beef heart. We have not gotten around to it yet. I hope in time to try all of these foods, including the dry meats.

The Secretary, Mr. Titcomb: I do think the food has a great deal to do with the quality of the eggs. Mr. Walters, of the Cold Spring Harbor Hatchery, tells me that when he raised some trout and fed them on mussels—he is right near the shore—he could not get good eggs from trout fed on salt water mussels. I am not entirely satisfied, and he has asked me to try it again some time.

We have had this same trouble with the commercial eggs this year, and have been hoping to get more wild eggs and see what the difference is. It was not a fair year for comparison. It was a very unusual season for taking eggs and for shipping them, and I am not prepared to say whether the trouble was with barren fish, or partly due to complications in transportation. The eggs would be on the road a month instead of three days. When received, the foreman would report them frost-bitten or frozen. We had one case

shipped from Pennsylvania which wandered around the country for a month and finally reached the hatchery from which it was shipped without any tags on and with the eggs all frozen.

I wish you would all consider this point. We distribute eggs from various commercial dealers to all of the hatcheries which handle trout. We buy from as many commercial dealers as we can get reasonable prices from and feel sure that the eggs are good. We keep a record of the eggs from year to year. In other words, we rate each dealer as to the percentage of hatch. Each foreman reports the results from the loss of eggs received from half a dozen different dealers, for illustration, and then we know that if all of the foremen report a bad hatch of eggs from any one dealer, the fault must be with the barren fish, or with the method of handling at the original source and we drop that dealer from our lists. We try to deal with men whose eggs generally rank well at all of the hatcheries. We may find that there is a poor percentage of hatch at one hatchery, while the majority of the hatcheries give a good percentage. We then presume there was some fault in transportation, or in water at the hatchery, or in methods of hatching, and we give that dealer an opportunity to try again. If we who buy eggs throughout the country of almost all the same dealers, could compare notes, we might get some material which would be the basis for further investigations for the food which is fed the fish at the source of supply.

In regard to water supply, I want to say here what I say every chance I get, that you, who have the locating of hatcheries under your control, should test the water for eggs and young fish for at least a year before you invest the people's money in those hatcheries, and that if any political influence to locate a hatchery is brought to bear, you withhold your action until you have made that test, because you can save the people a great deal of money. You all know it. I do not have to go into detail either for the Bureau of Fisheries or any of the States.

Mr. Nevin, of Wisconsin: I wish to say, gentlemen, that in one of our hatcheries I have just the condition that Mr. Titcomb spoke of. The fish are most prolific, and the eggs which were hatched there are sent to our other hatcheries, where they do excellently, but at home in their own water they do nothing. We cannot keep them until they are six weeks old.

Studies on the Nutrition of Fish: Experiments on Brook Trout.

BY DR. SERGIUS MORGULIS.

(Read by Prof. Henry B. Ward).

This paper was awarded first place in the class of papers dealing with biological investigation of fish and fisheries problems. It has already been published (Transactions, Dec., 1918, p. 34).

Discussion.

The Secretary, Mr. Titcomb: This paper represents a tremendous amount of work, and it gives you just an inkling of what it means to come

face to face with the fish food situation. Some commercial hatcheries are boiling midlings and putting them in half and half to feed the fish. We have always wondered how much of that grain was digested by the fish. The paper goes right hand in hand with Dr. Embody's, but it shows what termendous difficulties one is under in keeping up with that side of the problem. We cannot get at it the way we can with terrestrial animals. But if this beginning made by Dr. Morgulis will lead to something, it means a good deal, because we never know fully the value of different foods we are trying until we know how much of those foods are assimilated by the fish we are feeding.

Dr. Geo. C. Embody, of Cornell University: I have been exceedingly interested by this paper. It is possible to reduce some of Dr. Morgulis' results to the same category as mine. For instance, what he calls the index is exactly the same as what I call the reciprocal efficiency factor, that is, one divided by the amount of food necessary to produce one pound of trout. Now you will recall that in the case of millings, I secured a cost production of one pound of trout at thirty-seven cents. The averages of his three experiments with raw beef hearts makes a direct efficiency factor of 2.15, and if hearts cost ten cents a pound, that means it costs only 21 cents a pound to produce the trout, twenty-one cents compared to thirty-seven in the case of liver—a distinct saving.

The paper furnishes us data for solving some problems that we have been wanting to solve for a long time. It shows a way for determining the correct nutritive ratio between the amount of protein and carbo-hydrate, a ratio which has been known for a number of years in the case of domestic animals. The difficulty of finding it in the case of trout is due to the fact that the nitrogen not only passes out by means of the feces, but through the urine. There is no way of separating the urine from the feces, and consequently no way of separating the nitrogen of the urine from the nitrogen of the feces, which must be done before one can determine with any degree of accuracy the correct nutritive ratio of these products with reference to trout. I think this paper goes a long ways towards the solution of that one problem, and will be exceedingly valuable for that as well as for many other reasons.

Dr. Henry B. Ward, of Illinois University: The paper is exceedingly difficult to grasp thoroughly when one reads it. It must be more so than when one sees it in print, because of the wealth of minute data of extreme accuracy, which goes to safeguard the general results. But I am sure there are some things which Dr. Morgulis would want to have indicated lest improper conclusions be drawn from the statements in the paper.

Now, as we know from feeding experiments with other animals, each kind of food must be tested by itself, and to determine that these foods, when cooked with the liver or beef hearts, are not as efficient as the same food uncooked, does not prove that the same holds true of all kinds of food uncooked.

If I remember correctly, Mr. Titcomb referred to the habit of certain persons cooking mixed foods containing a certain amount of plant material or grains. You will, many of you, who have attended these meetings for some years, recall the experiments of our dear friend, Professor Dyche, of Kansas, in raising fish on grain in the experimental fish ponds of that state. Now it is a very fair question to ask whether, if you were to attempt to utilize a food of the solid type of grain, or of the condensed sort of vegetable foods, some cooking is not necessary in order to make it possible for the fish to utilize it, and whether the lack of utilization found in some experiments, is not due to the lack of mere softening to put the food in such condition that the digestive processes can be carried out and the material utilized. You see the experiments there differ very radically from those on which Professor Morgulis was engaged.

The ultimate question in future will have two elements also, first, its degree of utilization, which Professor Morgulis has treated here quite carefully for individual foods; and, second, its cost. If half as much of one food is utilized, and that food would only cost one-third as much, it still might be the better food to use. The question of the degree of utilization once for all concludes the problem for the fish culturists of what kind of food should be used in practical work.

And then there is a third question, and that is the effect of mixed diet, for we know very well by animal experimentation in other cases that feeding with a single food substance and feeding with a mixture of food materials, are accompanied by quite different relative results, and the amount of material utilized in a mixture may be quite different from the amount of some material which is used and results obtained in feeding with a single type of food. This concerns not merely different kinds of animal food, but also a mixture of animal plant food, and Prof. Embody had some very interesting suggestions concerning a mixture of different kinds of animal food. Of course I mention that here, not to contribute anything to the knowledge of the subject, but perhaps to keep some of you from drawing indirect conclusions from this or some other paper. Feeding with a single substance will show one element in the problem. It will not decide, however, the relative advantage of that substance over any other single substance, until the mixture has been tested. Until the question of mixtures as different as those of animal and plant food be tested, and until the question of cooking be tested on plant material, and all of these tests averaged with the cost, the man who wants to feed his trout cannot tell finally what is the most efficient food, that is, the food which can be fed at the least cost, and the best results secured.

A Study of the Effects of Certain Oils, Tars and Creosotes Upon Brook Trout (Salvelinus Fontinalis).

BY ADRIAN THOMAS.

This paper, with the discussion, appears later in this issue of the TRANSACTIONS, page 121.

President O'Malley then introduced Dr. F. T. Sun, President of the Fisheries School of Tientsin, China.

DR. SUN'S ADDRESS.

Mr. President and Gentlemen of the Society:

It is a great honor and pleasure for me to be present today and to have the opportunity of meeting your scientific and practical fisheries men assembled here in this convention of the American Fisheries Society. It had been my original intention during my study of the fisheries of this country to permit myself the pleasure of a call upon some of you gentlemen in your various home cities, and to secure from you such information as you would be good enough to give me. I discussed my proposed itinerary with Dr. Hugh M. Smith, head of the Bureau of Fisheries in Washington, D. C., and asked him just how I could manage all this, and he suggested that it might be advisable for me to come to this meeting in order that I might here have an opportunity to meet all of you together and secure the valuable information which is bound to result from a meeting of this kind.

In China, as you doubtless know, we have various provinces stretching all along the coast. In addition, there are about fifteen provinces in the interior of the country. The coastal fisheries are inadequate to furnish sufficient fish for the interior provinces. On account of the difficulties of transportation, particularly, it is difficult for us to send salt water fish to remote provinces and as a result the price of the salt water fish is much higher than for those of the fresh water rivers and lakes. The Chinese seem to be very much more appreciative of the fresh water fishes, also, than of those caught from the salt waters.

We have some recent literature dealing with fish and fisheries in China, but for the most part our fish culturists and fishermen are working in their various sections according to information published in books that were prepared in the time of our forefathers.

More than ten years ago I proposed to our government the advisability of encouraging some of the more up to date leaders of fish culture in China. I suggested also that we strive to co-ordinate the scientific and practical work incident to our fisheries. We have found it to be somewhat difficult to get our practical fishermen to adopt the views of our scientific culturists.

Sometimes our practical men have thought they knew much more about such matters than our scientific men.

Also, it was a part of our newer ideas to establish fish aquaria and museums, and to establish schools or courses in schools that would teach practical and scientific methods concerning our fisheries. Ten and a half years ago our first school was established in Tientsin, China, and shortly afterwards schools were organized in three other cities, two of them in the southern part of China and one in the northern part. It is our earnest hope that we may shortly establish more schools in various provinces and in various parts of the several provinces—not only schools, but industrial institutes to teach the industrial and commercial work incident to fisheries. It is a part of the work of these schools to instruct the children along commercial lines with reference to fisheries, such as the manufacturing end of the business, the proper methods for sorting, smoking and canning fish, the construction of nets and all things which are in any way connected with fisheries. These studies were introduced very successfully among the young Chinese students. Sometimes the professors of a school will take their students in a body to various provinces and there will be an interchange of ideas and of information and thus we are able to spread the new methods of fish culture, manufacturing, etc. Splendid results have been noticeable in a very short time.

I thought, however, that I ought to secure information from countries other than our own and ascertain the best methods in use in various countries for fish culture and the practical side of fisheries, manufacturing, canning, etc.

We are making progress with our fisheries literature, and, in addition to the Chinese books which have been handed down by our forefathers dealing with this question, we have already translated a number of books from the English and have introduced books from the United States and from Japan. But some of our literature I consider rather out of date. So many new questions are coming up all the time and so many new methods and plans are being devised that, when I had the opportunity, I felt it to be incumbent upon me to come to this country and spend about four months visiting various states and examining the hatcheries in various points, and studying the question with the

fish experts in Chicago, Washington, Boston, Gloucester and other cities. I have secured much valuable information from the professors in your schools and from your commissioners along the line of fisheries, both as regards the industrial and scientific questions involved, as well as with reference to the food situation. Altogether, I shall have spent six months in this country. Everywhere I have gone I have received helpful information. You have made a great progress with this work in your country and it is known all over the world.

I have had the temerity to suggest in various places that you establish courses with reference to fish culture in your various universities and I have agreed to send photographs and information concerning what we are doing to those of you in this country who are interested. I hope that we may have the pleasure of communicating with each other in the future frequently and of exchanging information and ideas and I can assure you I shall always be glad to have you mail me any of your publications with regard to fish culture. In return I should be very glad indeed to submit to you any of our publications, only I am sorry they would be printed in Chinese characters and might be a little difficult to read.

In addition, as the world is small these days, I hope that it may be your opportunity in the near future to make a trip to the Orient, perhaps after the war, in order that you may study some of the conditions in China. I shall be very glad indeed to welcome you at any time.

President O'Malley replied briefly to Dr. Sun, thanking him for his address and assuring him of the honor the Society felt in his presence at the meeting.

The Chairman of the Committee on Resolutions, Mr. M. L. Alexander, presented the following resolution:

> As an evidence of the loyalty of this body, the Committee on Resolutions has decided to ask the Society that they remit the dues of all members who are now in the service of our government and that this resolution be passed upon immediately.

The motion was seconded by Mr. John W. Titcomb and passed unanimously.

The session was adjourned.

Tuesday Morning Session, September 10th.

After various announcements were made, President O'Malley, as Chairman of the Committee to further the amalgamation of the Pacific Fisheries with the American Fisheries Society, presented the following report:

Two years ago I was appointed chairman of a committee to look into the amalgamation of the Pacific Coast Fisheries Society with the American Fisheries Society. Last year the Pacific Coast Fisheries Society voted to amalgamate with this Society and we proceeded to take it under advisement and work it out, but when we got into the proposition, we found that the By-laws of the American Fisheries Society had defeated our cause, since they stated that we must have 100 members signed from the societies desiring to amalgamate. The Pacific Coast organization, I believe, had between seventy and seventy-five members at that time; therefore we can not go any further until action is taken by this society.

Secretary Titcomb presented the following, relative to the amalgamation of another society with this organization:

A few months ago, as representative of the Conservation Commission of this State, I attended a meeting of the National Association of Fish Commissioners. That was originally the Association of Shell Fish Commissioners, if I remember correctly. The members are more interested in shell fish than anything else. We therefore have this National Association of Fish Commissioners, the International Association of Fish and Game Commissioners and the American Fisheries Society, to a large extent working along the same lines—especially the National Association of Fish Commissioners, so far as the fisheries are concerned—and at that time the question was brought up of amalgamating that association with this one. It is quite a burden on some people to attend and on some states to send representatives to meetings of all these organizations at different seasons of the year, and it is a matter of criticism sometimes, when expenses are incurred by state officials for going out to so many of these meetings. I understand that there is here present a committee from the National Association of Fish Commissioners ready to talk over this question of amalgamating with the American Fisheries Society, and for that reason I move that the President be empowered to appoint a committee to confer with this committee of the National Association, with a view to amalgamation, and that he himself be included on the committee as an ex-officio member.

The motion was put and carried, and President O'Malley appointed Messrs. Geo. H. Graham, G. C. Leach and Raymond C. Osburn as members of the Committee.

The reading and discussion of papers was then resumed:

The Elimination of Stream Pollution in New York State.

BY DR. HENRY B. WARD,
University of Illinois.

This has already been published, together with the discussion which followed, in the TRANSACTIONS for December, 1918, pp. 3 to 25.

REPORTS OF THE TREASURER.

Annual Report.

To the American Fisheries Society:

I hereby submit my annual report as Treasurer, from the annual meeting in August, 1917, to August 21, 1918:

RECEIPTS.

Balance in the treasury		$ 664.24
Interest on deposits		7.39
Life membership		25.00
Annual dues:		
For year 1912	$ 2.00	
For year 1913	4.00	
For year 1914	8.00	
For year 1915	26.00	
For year 1916	68.00	
For year 1917	276.00	
For year 1918	60.00	
For year 1919	6.00	
		450.00
		$1,146.63

DISBURSEMENTS.

Per Cash Book:	
Exchange for August	$ .10
Rexford Holmes (Reporting, on account) S. V. 1	25.00
L. B. Rimbach, express 39c; clerical services as Treasurer pro tem Oct., 1916, to Aug., 1917	100.39
Carlos Avery, postage to August, 1917	23.16
Leader Printing Co., letterheads	8.25
Emerson & Co., rubber stamps	3.15
Postage	9.56
Clark & Fritts, June Transactions, etc	195.15
Deposit life membership fee in Permanent Fund	25.00
Postage	1.00
Clark & Fritts, Sept. Transactions	98.11
John W. Titcomb, postage	15.00
Joseph C. Pedlow, multigraphing	4.75
L. B. Rimbach, postage and telegram	.94
J. B. Lyon Co., letterheads and envelopes	9.90
Rexford L. Holmes, reporting 47th Annual Meeting, Aug. 29–31, 1917	125.67
M. Riddell, multigraphing	2.70

L. B. Rimbach, postage	11.00	
The J. C. Hall Co., receipt blanks	4.58	
John W. Titcomb, postage and express	16.64	
J. C. Pedloe, Jr., multigraphing	5.00	
Industrial Trust Co., advertising lost passbook	2.70	
J. B. Lyon Co., letterheads, etc	28.25	
Sphar & Glenn, December '17, and May '18 Trans	182.04	
Joseph C. Pedloe, multigraphing	4.00	
L. B. Rimbach, clerical services Aug., 1917, to Aug., 1918	100.00	
Gloucester National Bank, to cover check of Mr. Rew, deposited to account of American Fisheries Society, but proved uncollectible	2.00	
		1,004.04
Balance per Cash Book		$142.59

ARTHUR L. MILLETT,
Treasurer.

Gloucester, Mass., Aug. 21, 1918.

Mr. Millett explained that the above report does not include $125.00 paid out to cover bills for 1917.

PERMANENT FUND.

Concerning the Permanent Fund of the American Fisheries Society I have to report that this fund is on deposit with the Industrial Trust Co., Westerly Branch, Westerly, R. I., and the pass-book shows a balance of $2,995.96.

ARTHUR L. MILLETT, *Treasurer.*

Gloucester, Mass., Aug. 21, 1918.

The Auditing Committee, Mr. John R. Woods, Chairman, having already examined the accounts and pronounced them to be correct, the Report of the Treasurer was accepted.

The Treasurer, Mr. Millett, was compelled to leave at this time and Mr. Geo. H. Graham was appointed to serve in his stead during the remainder of the meeting.

The session was then adjourned.

Tuesday Afternoon Session, September 10th.

The discussion of Dr. Henry B. Ward's paper was continued for some time and the question was raised as to the best way to reach the people with information in regard to the pollution problem.

Mr. Geo. H. Graham moved that Dr. Ward be asked to prepare his paper immediately and that a copy be sent to each of the fish and game commissioners, and that they in turn give it publicity in the newspapers of the various states. The motion was carried.

Mr. G. A. Smith, of Oklahoma was called upon to read his paper entitled:

Stream Pollution.

This paper with the discussion that followed will appear in a later number of the TRANSACTIONS.

COMMITTEE ON RESOLUTIONS.*

The Committee on Resolutions, through its Secretary, Mr. John P. Woods, presented the following resolutions for the consideration of the Society:

I. WHEREAS, there are upon the roster of this Society the names of certian enemy aliens; and

WHEREAS, it is distinctly repugnant to the loyal spirit of this Society thus to harbor such undesirables and to be thus burdened thereby; therefore

Be it Resolved, that each and every such enemy alien be hereby expelled instantly from membership in this Society; and

Be it further Resolved, that any member who may have been or may hereafter be convicted of disloyalty to the United States be automatically expelled; and

Be it further Resolved, that the Executive Committee, with the Secretary, be invested with the authority to make all such eliminations, the Committee duly to second each disbarment, and to report back to the Society its findings and actions.

It was moved and seconded that this resolution be adopted, whereupon it was unanimously carried.

II. WHEREAS, the supply of red meats for the customary food purposes, but more especially and decidedly for the successful conduct of the war, to supply our army and our allies satisfactorily, is one of the prime objects to be now attained; and

WHEREAS, the suitability of fish as a human food presents itself impressively now, not merely as an acceptable substitute for meat, but as a beneficial food alternative, it being noted for its great bulk, its moderation in cost, and its otherwise general adaptability for food consumption; therefore,

Be it Resolved, that this, the American Fisheries Society, respectfully and faithfully dedicates its first and full aid, not only to the maintenance, but to the increase, of the supply of fish, promising further to employ its

*See also pp. 91 and 111.

skill and entire ingenuity to the end of attempting to overcome any of the perplexities of the present or the future, which there is any possibility to anticipate or formally respond to; and

Be it further Resolved, that a copy of this resolution be promptly forwarded to the Honorable Secretary of War and the United States Food Administration.

This resolution was also approved unanimously.

III. WHEREAS, there comes regularly to the serious attention of the American Fisheries Society the need of abatement of certain pollution of certain streams and certain tidal waters, which pollution in many cases is the result of oversight occasioned by the quick and abnormal growth of essential industry, and which in many cases also can be easily remedied without in any way impairing the usefulness of such industries; and,

WHEREAS, the aforesaid pollution is at present destroying great volumes of human food, with the imminent prospect of irreparable future damage;

Be it therefore Resolved, that the proper authority of the Federal Government be requested to call and to meet a conference committee from this Society purposely to consider certain measures to be proposed for control and abatement; and,

Be it further Resolved, that a copy of this resolution be forwarded to the Honorable Secretary of War, the United States Food Administrator, and the War Industries Board.

The reading of this resolution precipitated a somewhat lengthy discussion as to the advisability of asking government co-operation in such matters. Some of the members seemed to feel that the rights of the various states to full control of their fisheries and unnavigable waters might be involved.

The question was finally put to vote and the resolution carried with two dissenting votes.

Later action by the Society provided a committee which has been appointed by President Alexander.

COMMITTEE ON POLLUTION OF STREAMS.

Prof. Henry B. Ward, Chairman, University of Illinois; Mr. John N. Cobb, Director, School of Fisheries, Seattle, Washington; President E. A. Birge, Wisconsin University; Mr. Wm. C. Adams, Fish and Game Commission of Massachusetts; Mr. J. A. Williams, Shell Fish Commissioner of Florida; Mr. E. A. Tulian, Conservation Commission of Louisiana, and Mr. Seymour Bower, U. S. Bureau of Fisheries, Comstock Park, Michigan.

The following resolutions were acted upon at a later session, but for convenience in reference are inserted here.

IV. WHEREAS, federal provision for the erection of federal hatcheries has been made, and whereas the need therefor in the near future is imperative,

Be it therefore Resolved, that the American Fisheries Society respectfully urge the Bureau of Fisheries to use all possible speed in making operative the proposed hatcheries in so far as is compatible with interests not interfering in any way with the conduct of the war, and that a copy of this resolution be duly presented to the Bureau of Fisheries.

Carried unanimously.

V. WHEREAS, the conditions of the present have shown the need of developing the food resources of the country to meet the demands not only at the present moment, but also in the future, and

WHEREAS, the opportunities for securing specific training in the principles of fish culture are extremely limited if not entirely lacking in the educational institutions of the country, and

WHEREAS, such training is important not only in the service of the state and nation, but also to the individual land owner who can advantageously engage in fish production on a small scale in connection with his agricultural activities; therefore

Be it Resolved, that the American Fisheries Society recommend the establishment of courses in fish culture which will open a new field of activities for many who find themselves adapted to such work and at the same time furnish a force of trained workers to meet the demands of state and nation.

That this end may be achieved in the most effective fashion, the President of the Society is hereby directed to appoint a committee to consider plans of procedure.

The resolution was carried unanimously. President Alexander has since appointed the following:

COMMITTEE ON UNIVERSITY COURSES IN FISH CULTURAL WORK.

Prof. G. C. Embody, Chairman, Cornell University; Dr. R. E. Coker, U. S. Bureau of Fisheries; Mr. John W. Titcomb, State Fish Culturist of New York; Prof. Jacob Reighard, University of Michigan; Prof. Raymond C. Osburn, Ohio State University.

VI. *Be it Resolved*, that the American Fisheries Society in convention assembled, requests that the United States Bureau of Fisheries prepare a comprehensive plan for the protection and improvement of the Shad Fishery industry, including suggestions for necessary state legislation; and that when such plan has been prepared, it be forthwith submitted to the proper

authorities in each state interested in Shad Fisheries, with the urgent request for immediate co-operation, to the end that this great industry may be preserved.

Carried, with no opposing votes.

A committee provided for later has been appointed by President Alexander, as follows:

COMMITTEE ON THE REHABILITATION OF THE SHAD INDUSTRY.

W. H. Killian, Chairman, Baltimore, Md.; G. C. Leach, U. S. Bureau of Fisheries; Adrian Thomas, Richmond, Va.; F. Nash Bilisoly, Norfolk, Va.; Wm. C. Adams, Boston, Mass.

VII. WHEREAS, the Almighty has taken from our midst the following members, namely, Daniel B. Fearing, of Rhode Island; R. M. Hurley, of Pennsylvania; John S. Parsons, of Virginia; John R. Rew, of Virginia; A. R. Stark, of Pennsylvania; A. R. Whittaker, of Wisconsin; M. F. Stapleton, of Wisconsin; Frank E. Hitchings, of Massachusetts; and Dr. Richard Rathbun, of the U. S. National Museum; thus necessitating again the sorrowful record of deaths within the portals of this Society;

Therefore, be it Resolved, that this Society, realizing the extent of the loss, and moved by its feelings of deepest emotions and sympathy, does hereby indicate its full sorrow in its expression of bereavement over the newly made graves.

The resolution was unanimously passed by a rising vote in honor of the memory of the deceased members.

The reading of papers was resumed and Dr. Prince was called upon.

A New Form of Fish-way, with Models and Demonstration.

BY DR. E. E. PRINCE,
Dominion Commissioner of Fisheries, Ottawa, Canada.

This paper will appear, with discussion, in a later number of the TRANSACTIONS.

Minnesota's Experiment in State Fishing.

BY MR. CARLOS AVERY.
St. Paul, Minn.

This paper has already been published in the TRANSACTIONS for December, 1918, pp. 57 to 64.

Discussion.

MR. GEO. D. PRATT, of New York: Will Mr. Avery state how the cost was computed, who were employed to do the fishing and on what basis they were paid?

Mr. Avery: We made no computation to start with, except in a very general way. Our experience has shown that we can sell these fish at prices of one-half to two-thirds of the ordinary selling prices for the same varieties and pay operating expenses and provide equipment in some cases. We employ men experienced in fishing—fishermen, settlers and Indians living near the lakes. They furnish their own equipment and we pay them by the pound.

Secretary Titcomb: Did the sportsmen raise any objections? We have found it difficult to convince them that nets will not drain the lake of fish.

Mr. Avery: There was none when they understood what we were doing. We have not fished where there are any bass, and the only protected fish in the waters concerned were the white perch or wall-eyed pike, but they are of inferior quality and no one cares to fish for them. The only protests came from the wholesale fish dealers, but they have finally subsided and these men are now handling our fish.

Mr. W. E. Barber, of Wisconsin: The State of Wisconsin took up the matter of distributing rough fish generally throughout the state a year ago last May. The commercial fishermen operating in inland waters work under a state contract and they received for these rough fish four and a half cents a pound. The State Food Administration sent out circulars notifying the cities that the fish could only be secured by order from the State Conservation Commission. The various cities established markets and were allowed to charge five cents per pound. No butcher shop or other institution than the city was permitted to handle the fish and it worked out very successfully. Thirty or forty towns and cities took advantage of the opportunity and the people were very eager to buy fish. In no instance did it take over a couple of hours to dispose of the stock and some cities ordered as high as ten thousand pounds at a time.

Mr. John P. Woods, of Missouri: May I express my appreciation of the efforts that have been made towards starting a modern "eat fish" campaign. In my state we have no such opportunities. One feature appeals to me and that is the prospect of dissipating the idea that fish should not be available except on Friday. I had the honor of presenting a paper at the New Orleans meeting opposing the prevailing custom of eating fish only on Fridays and I am glad to welcome this innovation.

Territorial Waters and a Suggested Extension of the Three-Mile Limit.

BY DR. E. E. PRINCE,
Dominion Commissioner of Fisheries, Ottawa, Canada.

This paper, together with the discussion, will appear in a later number of the Transactions.

The session adjourned.

Tuesday Evening, September 10th.

At the invitation of Dr. Chas. H. Townsend, Director of the New York Aquarium, the members of the Society spent the evening at the Aquarium as guests of the New York Zoological Society. As the reception took the form of a "smoker," ample opportunity was afforded for the guests to inspect the numerous interesting exhibits of fishes and other aquatic animals at their leisure. Later in the evening a series of lantern slides and motion pictures of fishes and various fisheries operations was thrown upon a screen and refreshments were provided.

Wednesday Morning Session, September 11th.

Reading of papers and discussion.

A Tray for Sorting Fish.

BY WM. H. ROWE,
West Buxton, Me.

The importance of sorting fish is known to every fish culturist. From the time they begin to feed—and some grow faster than others—there is danger of the larger eating the smaller. As they grow it is an advantage to put the larger ones by themselves, and the smaller ones that are left have a much better chance.

Necessity may have led many a fish culturist to construct some such a device as I have made, but I have never seen one in any hatchery I have visited. The first year of my hatchery experience I sorted fish by picking them out of a tub of water one at a time and putting them into other tubs or pools, according to size. This method is very slow. I have tried a long box fitted with racks with wire or slats to hold the larger trout and let the smaller through, but this method was never satisfactory, as many of the fish that could go through would not do so.

A few years ago, having many fish on hand that needed sorting, (with little time to do it in and cold weather), I wondered if I could not use a tray such as is used for sorting apples or potatoes. I made such a tray about 3 feet long by 15 inches wide, with low sides about 2 inches high and having bagging tacked on the

bottom with strips of wood 1 inch by ½ inch. I also made a frame that would just fit on over the 2-inch sides and that could be easily removed. This frame, made of strips 5 inches by ½ inch, is to be used for larger fish when there is danger of their going over the low sides of the tray, but in most cases it is not necessary to use this.

I have found this tray one of the most convenient articles I have about the hatchery and it comes into almost daily use. For sorting fingerlings and yearlings, I place it on a box, open side up, about the size of the tray, that will bring the tray a foot or more from the ground and placed directly back of the pool into which the larger portion of the sorted fish are to be put. The fish are seined up and placed in a tub of water near the tray. One man, with a dip net, will take from the tub and put into the tray as many at a time as can be handled conveniently. A man or two by the tray can pick out the largest of the lot (and the smallest also if three sortings are to be made), and these are put into tubs and later into pools. Those remaining in the tray are tipped into the pool in front of the tray.

In most cases this saves taking in the hands a large proportion of the fish. A tub of yearlings, holding a thousand to fifteen hundred fish, can be sorted in fifteen minutes. In sorting for the market, those large enough to ship can be picked out by hand and the balance tipped back into the pool.

I make use of this same tray in spawning time, placing several trout at a time in it and taking the fish to be stripped from the tray. In this way they get rid of the water that would run into the spawning pan if the fish were taken in the hands from water, thus increasing the chances of good fertilization.

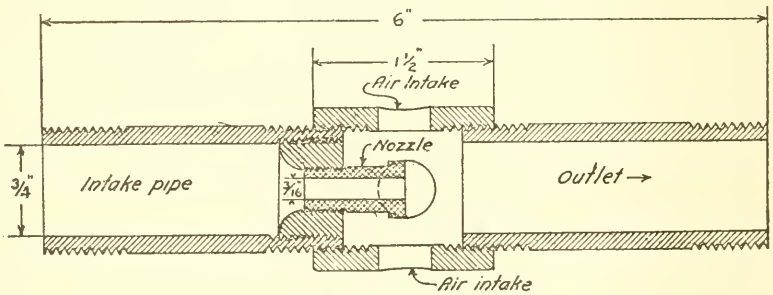
I have had several fish culturists from United States, state and commercial hatcheries working with me, but none of them had ever seen the tray used for sorting fish until they saw the one at my place. Although it is not in general use, I think, from its simplicity, someone must have made a device much like the one I have. It certainly is a great labor saver.

In the discussion which followed, Mr. J. P. Snyder, of Cape Vincent, N. Y., described a sorting tray which he had made, using galvanized wire screen on the sides of the tray. With the use of screen of various sizes any desired assortment could be made in a short time.

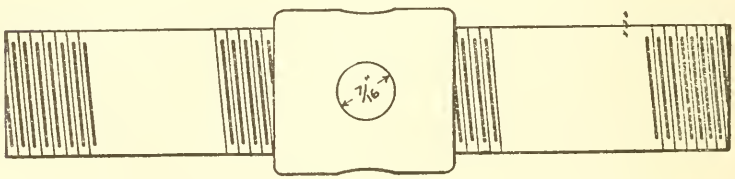
An Aerating Device.

BY JOHN W. TITCOMB,
State Fish Culturist of New York.

The New York State Conservation Commission recently had a live fish exhibit at the Rochester Exposition. The water supply was from a large lake inhabited by lake trout, white fish and several other species, but as supplied to the aquaria through the city water mains it evidently was lacking in air or something of that sort. We had no difficulty in keeping most of the fish in good condition, but we lost small-mouth bass continuously for the first two days of the exhibit, or until the city plumber who had installed the piping came around with this aerating device. It is patterned after the Bunsen gas burner. The water supplied to the aquarium, passing through this aerator, sucks the air through the holes in the union and carries it down into the aquarium, say fifteen or eighteen inches. When the pipe connected with this aerator was extended to the bottom of the aquarium, a depth of from 2½ to 3



LONGITUDINAL SECTION



ELEVATION

Plan of aerating device, as devised and constructed by Mr. Norman Price, Rochester, N. Y., reduced one-third.

feet, there was not sufficient force in the discharge of water to carry the air to the bottom, but some of the water would discharge through the air holes in the union. Any difficulty of this sort can be adjusted so as to use the minimum amount of water and, at the same time, force into the aquarium a considerable amount of air. The aerator is attached to the regular supply pipe leading to the aquarium and setting vertically a few inches above the water level. The nozzle shown in the drawing is not absolutely necessary, the water discharging directly from the plug in the intake pipe having sufficient force to suck the air through the holes in the union and driving it into the aquarium.

This simple device was suggested by Mr. Norman Price, a plumber who had never had anything to do with fish except to catch them. After it was applied to the aquarium containing the small-mouth bass we did not lose a fish. It is proposed to install the device in every one of the aquaria, not only to improve the condition of the water for all the fishes, but because it permits the use of less water. The size of the pipe and the size of the holes both in the union and in the nozzle or plug may be varied to suit conditions.

Discussion.

Dr. R. C. Osburn: I wish to ask Mr. Titcomb if the air is well distributed in small bubbles. With compressed air driven through wooden plugs there is a very fine distribution of the air, but if this apparatus is effective in that respect it does away with all secondary means of aeration and should be especially useful for temporary aquaria.

Mr. Titcomb: The air is broken up into a cloud of white. The amount and the size of the bubbles can be regulated very largely by the pressure under the control of the supply valve.

Mr. Chas. O. Hayford, Hackettstown, N. J. This device should be very useful to hatcheries. In those that use spring water, there is often a great lack of oxygen. Another thing that troubles us is the jumping at the intake of our ponds and this device should tend to eliminate some of that. It is so inexpensive that it is worthy of a trial by all of us.

Mr. G. C. Leach, U. S. Bureau of Fisheries: How far above the water is the apparatus placed, and have you ever experimented with low pressure, such as is usually in use around hatcheries?

Mr. Titcomb: It makes no difference where you place it, the air is carried successfully. We have not experimented with low pressure. I think there is a chance for experiment by varying the size of the holes according to the amount of water you have.

MR. LEACH: It will be an interesting experiment to try this with a three-inch pipe. If it works well with pipe from two to three inches, we could use a very low head of water at the intake, with a larger opening, and it might prevent the fish from jumping and also aerate the water.

Model of a Riffle Pond, for Rearing Small Fingerling Trout.

DESIGNED BY MR. GEO. A. SEAGLE,
Wytheville, Va.

PRESENTED BY MR. G. C. LEACH,
U. S. Bureau of Fisheries.

The ponds are constructed entirely of concrete, except outlet pipe and guard-screens, and are from 4½ to 9½ feet wide and 50 feet long; with water 6 to 10 inches deep at upper end, and 20 to 30 inches deep at lower end when pond is filled. These ponds were first built without riffles, but were unsatisfactory, as the fish would crowd around the foot screens and in the corners of the pond. At that time only about 5,000 No. 1 fingerling fish could be kept in one of the small ponds, and it was necessary to take them up for treatment for a slimy affection every ten days or two weeks, which was always attended by some loss of fish. The riffle ponds have been in use two seasons, and have given excellent service; from 30,000 to 35,000 are carried successfully where only 5,000 were carried before the ponds were changed. In several instances the fish were placed in the riffle ponds before they had been fed, and they were reared to No. 2 fingerlings with only one change, and that was for the purpose of assorting the fish as to size.

The riffles were designed to furnish a means to exercise the fish, which is very essential to keep the young fish in a thrifty condition. To exercise the fish it is only necessary to draw out the first paddle, which will reduce the water to the desired depth, and the fish will scatter out to all the compartments. When they are properly constructed, and are working well, the water should be about 1¼ inches deep above the riffle, and ¼ to ⅜ in. deep at the foot of the riffle above. This is easily governed by placing the riffles at the proper distance apart, according to the drop in the bottom of the pond, which should not be very great, say about one inch in four feet. From 25 to 40 gallons of water per minute

is about the average supply, but that can be determined by local conditions. The working of the riffles will suggest the proper amount of water to be used for good results.

Discussion.

In answer to questions, Mr. Leach explained that the fish were sometimes placed in the pond before they are large enough to require feeding and that 35,000 to 40,000 fingerlings, up to four and a half inches long, can be carried successfully where before not more than 5,000 could be handled. At night the pond is allowed to fill and in the morning is drawn down so that the fish distribute themselves over the various riffles.

SECRETARY TITCOMB: The fish culturists here know well enough that a fifty foot pond five feet wide should be able to carry more than 5,000 fry to start with. Mr. Seagle, who is one of our most ingenious fish culturists, has overcome a condition of the water in which he was able to carry only 5,000. I think the very idea he has used is something we should experiment with in all our ponds. Perhaps the ponds in which we now carry 35,000 may be made to carry 100,000 or more. While he has overcome a local condition, the suggestion may be just as valuable for all of us to consider.

MR. LEACH: That is the idea. It would seem that many stations could increase their carrying capacity or conserve their water supply.

MR. DEROCHER: The device is a very good one, but I would suggest a change in the outlet of the pond. The drain should be arranged to come down flush with the end of the pond, thus avoiding dead water pockets which give a chance for sediment and waste to collect.

MR. LEACH: The criticism is a good one. I would prefer the outlet so placed.

The Shad Outlook.

BY MR. J. P. SNYDER,
Cape Vincent, N. Y.

The paper read by Mr. Snyder, with a digest of the discussion which followed, appears in this number of the TRANSACTIONS at p. 113.

The Development of Fresh Water Mussels and Their Culture.

BY DR. ARTHUR DAY HOWARD,
U. S. Bureau of Fisheries Biological Station, Fairport, Iowa.
(Read by Dr. Raymond C. Osburn.)

This valuable paper has not yet been published.

The session adjourned.

Wednesday Afternoon Session, September 11th.

Secretary Titcomb called the attention of the members present to the necessity of meeting their annual dues in order to keep up the publications of the Society. He also urged them to use their influence in securing a larger membership for the Society, pointing out the fact that the publications of the Society afford the only means for commissioners and fish culturists to keep abreast of the times in this particular subject.

REPORT OF COMMITTEE ON TIME AND PLACE OF MEETING.

Mr. John P. Woods, Chairman, reported that the committee had met in joint session with a similar committee from the International Association of Fish and Game Commissioners. Invitations were considered from Jacksonville, Chicago, Philadelphia, Buffalo, St. Louis, Louisville and Albuquerque.

The Committee recommended that the invitation presented by Mr. Theo. Roualt, Jr., State Game Warden of New Mexico, to hold the 1919 meeting in Albuquerque, New Mexico, be accepted, and that the time be set for the week beginning Monday, Sept. 15.

The report of the Committee was not acted on at once, but later in the meeting Mr. Wm. C. Adams, of Massachusetts, presented a motion to the effect that the Society designate Albuquerque, New Mexico, as the next place of meeting, provided that in the opinion of the Executive Committee at or near the usual time for issuing the annual announcement, war conditions warrant meeting at that place, and provided further that other conditions, in the opinion of the Executive Committee warrant the calling of the meeting at Albuquerque.

This motion was unanimously carried.

REPORT OF COMMITTEE ON NOMINATIONS.

Dr. Henry R. Ward, Chairman of the Committee presented the following names of members as the unanimous selection of the Committee for the officers of the Society for the year 1918–19:

President.....M. L. Alexander, New Orleans, La.
Vice-President.....Carlos Avery, St. Paul, Minn.
Recording Secretary.....John P. Woods, St. Louis, Mo.
Corresponding Secretary.....Chas. H. Townsend, New York City
Treasurer.....Arthur L. Millett, Gloucester, Mass.
Editor.....Raymond C. Osburn, Columbus, Ohio

Executive Committee.

N. P. Buller, *Chairman*.....Harrisburg, Pa.
George D. Pratt.....Albany, N. Y.
W. A. Found.....Ottawa, Canada
Wm. H. Rowe.....West Buxton, Me.
W. E. Barber.....Lacrosse, Wis.
W. H. Killian.....Baltimore, Md.
Carl Westerfeld.....San Francisco, Cal.

Committee on Foreign Relations.

Geo. Shiras, 3d, *Chairman*.....Washington, D. C.
Hugh M. Smith.....Washington, D. C.
Wm. G. Adams.....Boston, Mass.
James White.....Ottawa, Canada
C. H. Wilson.....Glens Falls, N. Y.

Committee on Relations with National and State Governments.

Geo. H. Graham, *Chairman*.....Springfield, Mass.
W. L. Finley.....Portland, Ore.
Jacob E. Reighard.....Ann Arbor, Mich.
E. T. D. Chambers.....Quebec, Canada
Henry O'Malley.....Seattle, Wash.

It was moved and seconded that the Secretary be instructed to cast a unanimous ballot for the Society. The motion was carried and the President declared the officers elected for 1918–19.

The Committee begged for more time in which to present the names of Vice-Presidents of Divisions and later, at the evening session, the following were elected:

Vice-Presidents of Divisions

Fish Culture.....Dwight Lydell, Comstock Park, Mich.
Aquatic Biology and Physics....Henry B. Ward, Urbana, Ill.
Commercial Fishing.....Charles Lay, Sandusky, Ohio
Angling.....J. M. McDougal, Gunnison, Colo.
Protection and Legislation..Geo. A. Lawyer, Washington, D. C.

A resolution in regard to the protection and improvement of the Shad fisheries, drawn up by Mr. Wm. C. Adams, of Boston, Mass., was presented at this time by the Resolutions Committee and acted upon. See Resolution VI under the heading "Report of the Committee on Resolutions."

Food Studies in Relation to Pond Fish Culture.

BY AUSTIN F. SHIRA,
Director, U. S. Biological Station, Fairport, Iowa.
(Read by Dr. Raymond C. Osburn.)

This paper will be published later. It was briefly discussed by Messrs. Titcomb, Osburn and Woods.

President O'Malley introduced the President-elect, Mr. M. L. Alexander, who made a brief address:

"*Mr. President and Gentlemen of the Society:* First I wish to congratulate you upon the success of this splendid meeting and upon the successful administration of the past year under the direction of our President, Mr. O'Malley. I wish, also to express to you my deep appreciation of the great compliment you have paid me, personally, in electing me to the presidency of this, the first society of its kind in the United States and possibly in the world, and to assure you that I feel the honor deeply. This honor will be appreciated not only by the people of my state but also of that entire section of the country. I am neither a scientific nor a technical man, but in the administration of the office of president and of the affairs of this Society I hope to be able to put into that work the best that's in me, and through the co-operation of the scientists and technical experts in our organ-

ization we will carry this Society to a higher degree, if possible, throughout the administration of the next year.

"At no time in the history of the Society has there been more important work for us to perform. The needs of the government at this time are great indeed, and it is our duty and our obligation to offer to our government at this time our heartiest co-operation and support in carrying out any measures suggested for the production of more sea-foods and fish-foods, so that the government will have the greatest utilization possible of the meats which are so necessary for our armies and those of our allies. Therefore, I call upon every member of this Society and every state commissioner belonging to it, to give to the government his best support in the production of more fish for food and in the education of the people in the eating of fish. Further than that, I believe it is our duty to see that fish food is supplied to the people of the United States at a price at which they can afford to purchase it and not be forced to eat meat.

"We should take up with great vigor this question of the pollution of streams which has been considered with such seriousness at this meeting and do everything possible to back up any movement to eradicate this great evil that exists throughout the whole land, so that our streams will supply the requisite amount of fish food.

"We should take up our work along constructive lines, so that this Society will stand for something that makes for the real good and the larger development of the great resources of this nation."

A motion was passed instructing the Secretary of the Society to extend the thanks of the Society to the New York Zoological Society for the previous evening's entertainment at the New York Aquarium.

REPORT OF THE COMMITTEE ON AMALGAMATION OF THE NATIONAL ASSOCIATION OF FISH COMMISSIONERS WITH THE AMERICAN FISHERIES SOCIETY.

The chairman, Mr. Geo. H. Graham, stated that the Committee had met, and, after much discussion of the matter, decided to request that the matter be laid over until the next annual meeting. The reasons for this delay are, that the By-laws of the American Fisheries Society do not at present permit of the amal-

gamation with other organizations having less than one hundred members, which would exclude the society in question; and, second, it was thought best to inform all of the members of the National Association of Fish Commissioners (formerly the Shell-Fish Commissioners Association) by letter, of the proposed amalgamation and state the idea to them explicitly. In the meantime the American Fisheries Society may well modify its By-laws in such a manner as to permit the amalgamation.

The session adjourned.

Wednesday Evening Session, September 11th.

The members of the Society were entertained at a clam bake as the guests of the New York Commissioner of Conservation, Mr. Geo. D. Pratt, at his Long Island home, an occasion long to be remembered by those present. At the close of the feast the Society was formally convened for the transaction of remaining business.

COMMITTEE ON NOMINATIONS.

Dr. Henry B. Ward, the chairman, submitted the list of names for Vice-Presidents of Sections and the Society unanimously voted for their acceptance as officers. The list oppears on page 108, along with those of other officers of the Society.

COMMITTEE ON BY-LAWS.

The Committee, through its chairman, Dr. Ward, recommended the following changes:

I. Amending Article III, first paragraph, to read as follows: "On presentation of a formal written petition signed by one hundred or more members, or by vote of the Society together with the written request of the officers thereof, the Executive Committee of the American Fisheries Society may approve the formation in any region of a section of the American Fisheries Society to be known as the ——— Section."

II. Amending Article IV, last paragraph, to read: "Vice Presidents of sections may be called upon by the President to present reports of the work of their sections, or they may voluntarily present such reports when material of particular value can be offered by a given division."

These changes were unanimously approved by vote of the Society.

COMMITTEE ON RESOLUTIONS.

The secretary of the Committee, Mr. John P. Woods, presented Resolution No. VI (see page 97), which was approved.

Mr. M. L. Alexander, as chairman of the Resolutions Committee, claimed the privilege of presenting the following resolution in person:

Resolved, that the American Fisheries Society and the International Association of Fish and Game Commissioners hereby express their very great appreciation of the delightful and open-handed hospitality which has been extended to us on this visit to New York, and especially for the great treat afforded us last evening by Dr. Townsend and the New York Zoological Society, and for the gracious hospitality extended to us this evening by Mr. Pratt, Conservation Commissioner of the State of New York; and also that we extend our thanks to the members of the Local Committee for their work in connection with this very successful meeting.

It is gratifying to know that we have met here as representatives of all parts of this great country, that any sectional lines which may have existed in the past have been obliterated, and that we stand shoulder to shoulder, working for one common cause, desiring to do everything possible to aid our government in its endeavors to carry on this great war to a successful issue.

The resolution was unaimously approved by a rising vote.

Commissioner Pratt, the host of the evening, was called upon and responded with a brief address.

COMMITTEE ON AWARDS.

The secretary of the Committee, Dr. Henry B. Ward, presented the following report:

The Committee feels that the society is to be congratulated on the response that has been made to the plan proposed by President O'Malley, under which prizes have been offered for new contributions in this field of activity. Sixteen papers have been offered in competition for these prizes and among them are so many of originality and value that the adjudication of the prizes has involved both intensive and time-consuming study by the Committee.

One of the papers, entitled "Working Plans for Increasing Fish Production in the Streams of Oneida County," has been submitted for consideration by the New York State Conservation Commission. The Committee is of the opinion that this does not fall within the terms of the competition because (1) it has not been submitted by an individual member, and (2) it has already been published. However, it represents so new and important

a line of investigation that the Committee wishes to recommend a vote of Honorable Mention to the New York State Conservation Commission for the scientific work organized and conducted under its auspices, as especially represented by the survey of Oneida County submitted to the Committee. Only one paper on the problems of the commercial fisheries has been submitted for consideration, viz.: on "The Development of Markets for Neglected Fishes," by Lewis Radcliffe, U. S. Bureau of Fisheries.

This appears to the committee to constitute a most valuable summary of the important work done in introducing new fishes and extending the knowledge of foods and increasing public demand for them. It seems in consequence to be historical and not exactly within the scope of the competition. Therefore the Committee recommends that no prize be awarded under this heading.

For the best contribution on biological subjects a prize of $100.00 was awarded to Dr. Morgulis for his paper on "Studies on the Nutrition of Fish: Experiments on Brook Trout."

For the best contribution on fish culture a prize of $100.00 was awarded to Dr. Embody for his paper on "Results of Some Trout Feeding Experiments Carried on in the Experimental Hatching Station of Cornell University."

President O'Malley called upon Mr. E. T. D.. Chambers, Deputy Commissioner of Colonization, Mines and Fisheries for Quebec, Canada. Mr. Chambers responded with a brief address in which he expressed his pleasure that our "marching together in a common cause has largely done away with those old divisional lines which formerly separated our beloved countries." He presented an invitaiton from the Commission of Colonization, Mines and Fisheries of Quebec to hold an annual meeting of the American Fisheries Society in Quebec in 1920.

President-elect Alexander accepted the chair for the remainder of the session at the invitation of President O'Malley, and called upon Dr. F. T. Sun, President of the School of Fisheries of Tientsin, China. Dr. Sun replied briefly, expressing the pleasure he had experienced in attending the meeting and invited the members to visit him in China. He explained his inability to continue at length as due to the elaborate banquet and also to the fact that the other members had the advantage of him by thirty years or so in the use of the English language.

President-elect Alexander brought the meeting to a close with a few remarks and the Forty-eighth Annual Meeting of the American Fisheries Society was formally adjourned.

THE SHAD OUTLOOK (Alosa sapidissima).

BY J. P. SNYDER,
Cape Vincent, N. Y.

During the spring of 1917, while assisting the Maryland Conservation Commission, the writer spent several weeks among the fishermen along the following rivers: Pocomoke, Wicomico, Nanticoke, Choptank, Tuckaho, and Chester. Particular attention was paid to those parts of these rivers that are the natural spawning beds of shad. This was done with a view to getting some definite idea as to the number of shad that spawned on these beds as compared with fifteen or twenty years ago. In this report no reference is made to men who were not actual fishermen for shad, either with pound nets or with gill nets, and who had not fished successively for fifteen or more years, and every effort was made to impress upon them the necessity of being honest and conservative in their answers. The men individually were asked to give, as near as they could recall—and quite a few had records to which to refer—the smallest, the largest and the average catch made per day's fishing during the springs of 1916 and 1917. Then they were asked to go back in retrospect and give as near as they could recall their smallest, largest and average catches per day's fishing in 1902 and 1903. All this information was taken down and tabulated and from these tabulations averages were worked out.

On the Pocomoke River, from Pocomoke City to Snowhill, seventeen fishermen were interviewed. It was shown from the testimony of these men that only one-tenth as many shad reached their natural spawning beds on that river in 1916 and 1917, as compared with 1902 and 1903.

On the Wicomico River from Salisbury to eight miles below that city, according to the testimony of nineteen fishermen, but one-twelfth as many shad returned in 1917 as did fifteen years before that date.

Twenty fishermen were interviewed along that part of the Nanticoke River from Woodland, Del., to Sharptown, Md. According to the information given but one shad was taken per net in 1916 and 1917 as compared with fifteen during the springs of 1902 and 1903.

Along the Choptank River from Hillsboro to Williston twelve shad were taken per net in 1903 as compared with one in 1917. The same ratio held good on the Tuckaho in the vicinity of Ridgley.

This same ratio also held on the Chester River from Chestertown to Millington, according to the testimony of twelve fishermen of record.

Along all these rivers the testimony of the men of record was strengthened by the testimony of many men who fished years ago, but not in recent years, and by other men who fished only during recent years.

During the spring of 1918 the writer spent a couple months on the headwaters of Chesapeake Bay; on that part of the bay that was long noted for the vast number of shad that collected there each year to spawn; where the Bureau of Fisheries, years ago, made such great records in the propagation of these fish. On these beds years ago Callighan and Hogan, and over near Charlestown, Barnes, operating large seines, frequently captured from 500 to 2,000 shad at a haul. Last spring parties operating a seine more than a mile long on these same beds rarely took more than two or three shad at a haul, while the largest single catch made was but seventeen shad and many hauls were made when not a single shad was taken. Just above Perryville, Md., on the Susquehanna River, where for many years four seines have been operated and where years ago each seine took from 1500 to 3,000 shad per season, last spring less than 200 shad per seine were taken. The number taken in pound nets on these beds in recent years has not exceeded one-twelfth as many as were annually taken fifteen years ago. On these flats where, years ago, hundreds of men drifted nets for shad and where catches of 200 and even 300 shad per night were made, last spring not more than twenty men fished and they fished for shad only for a short period, for shad were so scarce on these natural spawning beds that fishing for them did not pay even at the exorbitant prices received. And this was true in spite of the fact that all of these men set from half a mile to more than a mile of net, as was done years ago when such large catches were made. Catches of twenty shad per mile of net were unusual and this at a time when the very largest catches should have been made. The average catches were less than half that number and frequently not a

single shad was taken in a night's fishing. Two experienced and successful fishermen, in the height of the season, in four successive nights succeeded in getting but one shad.

What does this mean? What can it mean but the rapid approach to the end of the shad industry in Chesapeake Bay?

Every living creature is subject to the laws of reproduction. Only in that way can life be perpetuated. This is just as true of shad as of any other form of life. It is so self evident and true that it seems there could be no need of light on the part of any one. Among the shad fishermen of Chesapeake Bay and its tributary rivers there is no clear, fixed uniformity of vision as to the cause of the unsatisfactory condition of the shad industry, which all recognize as unsatisfactory. All the fishermen, however, can roughly be placed in two groups. Each group holds fairly fixed opinions as to the cause of the scarcity of shad, but the views of these two groups—and they include all shad fishermen whether gill-net or pound-net men—are entirely antagonistic. Roughly, in one group can be placed all the men fishing regularly in brackish or salt water. In the other group may be placed all men fishing in the bay or tributaries above brackish water, or in other words, on the spawning beds of the shad.

When remedial measures are mentioned to the first group they almost invariably point to the fishing permitted on the spawning beds as the cause of the trouble. They say: "There's your trouble. Cut out the fishing up there. Let the shad alone on their spawning beds and they will become as plentiful as in years gone by." The above is fairly representative of the views of this group and it is simply surprising how positive many of the men are in giving expression to this view. Having given expression to the above, they speak of the catching of shad all ready to spawn as though it ought to be deemed criminal. They lose entire sight of the fact that every roe shad coming into the bay will reach, if let alone, the condition in which they so severely condemn taking them. They forget that the eggs in a shad are as surely lost when the fish is taken enroute to its spawning bed as when taken on the beds prior to its spawning.

Those belonging to the second group invariably point to the excessive fishing done farther down the river or bay as the cause of the trouble. They will tell you of the days gone by when ten

or twenty times as many men fished on the beds of the shad as at present and all caught fish. Then they point to the great increase in the number and amount of netting set for these fish farther down the bay. They will tell you that unless there is a limit put on the fishing farther down there will be no need to forbid catching shad on their spawning beds for only a few get up there now. Then they turn to the other side, the side of justice. "Why forbid us to catch a few shad for our families or for market, and that is all we are getting now, while every one in a position to fish farther down may use any net or device in getting shad?" But you say, "This is the spawning bed of the shad," and they answer by asking what possible difference that can make, and the writer is willing to confess that as applied to shad and some other forms of wild life that need not be mentioned here, he has never been able to answer that question in a way entirely satisfactory to himself.

The truth is, both groups fail to grasp the real cause of the trouble, although both groups see it as modified by selfish or personal interests. The cause is to be found in excessive fishing and the remedy in limitation. To be just, this must be applied to all. Even if the taking of shad is forbidden on their spawning beds it will not be effective in bringing about the desired result so long as no restriction is placed upon taking shad enroute to these beds, for the number now reaching the beds is entirely too small to restore the fishery to what it was years ago, or even to perpetuate their present numbers.

There are many men in Maryland, both in public and in private life, who see and see clearly what is needed to correct this unsatisfactory condition of the shad industry, and many of these men are giving their best thought and effort to finding a remedy, just as there are other men in other states working along the same line, but it is almost hopeless to expect uniform remedial action by the various states interested in time to save this industry. The work of these men is not to be discouraged. They deserve the co-operation and commendation of all, but the writer believes, as do many others, that the remedy is to be found in Federal action. Isn't there some definite or concrete way by which this Society can help in this movement for Federal action? Simply as a suggestion the question is asked: Would it be wise to appoint a permanent committee of members interested, coming

from states interested, to act as a head, or nucleus to all, whether members of this Society or not, who are interested in bringing about Federal action?

As the spawning beds of the shad and the channels through which they must pass to reach these beds are navigable waters, it seems certain that the Federal Government has authority to take action. The question arises, however, as to how far this action should go and along what lines? I believe this Society should take a definite stand on this question of the shad outlook with a view to bringing about uniform remedial state or Federal action. This is a question that is so pressing that its action should not be deferred. It is for this reason that I bring the matter to your attention. We all take pride in establishing new fish in our waters, but let us also take the same pride in the perpetuation of those which nature has placed there.

Discussion.

Mr. Marshal McLean, of New York: The Conservation Commission of New York is tremendously interested in the shad question. In years past the Hudson River was very valuable from this standpoint. But the shad fishing there, like those farther south, has dwindled away, probably due to two causes. At least one of these has been intensive fishing, without proper regard to reproduction; the other is the pollution of the river.

I am glad to say that most of these questions are now coming within the grasp of the proper authorities here in the state. Until last year the commission had authority only over the upper reaches of the river, as far down as Verplank's Point. Last winter the legislature placed the entire river under the jurisdiction of the commission. This means that nets had to be removed from the river from Friday night till Monday morning and the mouth of the river opened up during that time. Mr. Pratt has been making a study of the river and of the spawning beds and of the fishermen themselves, as described by the last speaker. The men who fished on the spawning beds complained of the men at the mouth of the river, and the men at the mouth of the river complained of the men fishing on the spawning beds. But now we have taken away the privilege of fishing from the mouth of the river during a certain period of each week. Perhaps for a week or two that is going to be extended still further to give the fish a chance to get up the river. Some of the fishermen themselves have recommended that certain areas of the spawning grounds on the upper reaches of the river be declared closed territory, and no fishing on it allowed. We hope to get some good results from that. If you close the door to these fish they cannot get in to reproduce, and if they cannot reproduce we are going to lose them. I think it would help the work enormously along the whole coast line if an association having the weight that this one has would take some affirmative action in regard to this matter.

Mr. H. L. Gibbs, of North Carolina: This matter of the shad industry is one of great interest in our state. The value of the shad shipped from North Carolina is about three million dollars a year on an average. The bulk of the shad in North Carolina is taken from Pamlico and Albemarle Sounds; they come in at Hatteras and Oregon Inlets. Prior to this year most of the shad came in at Hatteras Inlet and up Albemarle Sound and the Roanoke River. This year they came in principally at Oregon Inlet and more shad were taken in that section of the state.

Now, speaking of federal control, I think that the government can co-operate in most of these phases of the fishing industry. I would like to suggest our idea about it. We have conservation laws in the state of North Carolina which I believe have been conceded by Secretary Redfield, who publicly stated this in his very able address in Wilmington in 1916, as being the best laws in any state in the Union, for conservation and the progress of the industry. In the year 1915, when the first general fish laws covering the whole state were passed, they provided, or rather established a commission. The first commission was composed of five men appointed by the governor, none of whom could have any financial interest in any fishing industry. This commission elected a commissioner who had general supervision over the fishing industries of the state, who made all other appointments. He was allowed two assistants by and with the consent of the commission. He appointed and the commission confirmed. The commission appoint their other help. The commissioner appoints his inspectors, he employs everything and does everything else pertaining to the industry. The commission's power and authority by this act was as follows: That the Fisheries Commission Board is hereby authorized to regulate, prohibit, or restrict in time, place, character and dimensions, the use of nets, so that this commission does not have to wait for the act of the legislature of the state if it's necessary to change the size of a net, or to say that you can fish in this place today and you shall not fish there tomorrow, for the benefit and for the good of the industry. It does not have to wait for the legislature to meet and change that statute, but the commission has the authority to say what size nets shall be used in that place, and what size shall be used in the other place, and at what particular place they may be used, and at what particular time they may be used. I am making these remarks because in the last address my attention was called to the fishing in Albemarle Sound.

The commission also has authority over the use of nets, appliances, apparatus and other means for killing fish, to regulate the seasons at which the various species of fish may be taken in the several waters of the state, and to prescribe the minimum size of fish which may be taken. The act of the legislature of 1917 amended that by making the purchaser or anybody else who had undersized fish in his possession subject to arrest and guilty of a misdemeanor, and the cases were heard by a superior court judge and not by a justice of the peace. Handling these violators has been a great deal of trouble with us, but by taking them before our superior court we have been able to enforce the law.

The first two years, 1916–1917, I tried ninety-six cases and prosecuted the majority of them myself, in the interest of saving of expense, because we are limited in revenue. Only two cases were lost out of the ninety-six. This year, or rather since 1917, the prosecutions have been a little over a hundred. I have had thirty-nine cases in one county of Bladen for the violation of the shad act and convicted all of them.

Now along the line of conservation, your legislatures should appoint commissions and give them proper authority. If the commission should find today that an act had been committed which was proper a year or a month or two before, but that it was necessary to stop it right away in the interest of conservation, and if they could meet together any day and do it, why, in such a way you can handle conservation. We have done it very successfully.

Now, referring to the Albemarle shad business, the government has a fish hatchery in our state, and it is a very nice thing for North Carolina. It has not been so very successful for the last two or three years, but I am satisfied that it will be in the future. The management, prompted by one or two local men right at that place, worked up some feeling against it. It was not intentional, but they just did not manipulate things properly, and they could not get the eggs they needed.

There was a law providing that on certain grounds in this sound, called the hatching grounds, the men should not set a net except between four o'clock and eleven o'clock in the afternoon, that being the time that the superintendent wanted the eggs for hatching. That was limited to the set net, stake nets or anchor gill nets. Pound nets set in the sound were allowed to stay all the time with no restrictions, so that the man who could only buy and furnish a little net and could not handle a pound net was limited in the time, by statute, when he could take the fish for a livelihood; whereas the other man was allowed to take them all the time, and that was what brought about the feeling. In order to allay that feeling and to help the hatchery achieve success the Board at a meeting in October of 1917, passed a rule which went into effect right away, because they had authority to do it, and this rule is bringing about now the good feeling which you will find existing between the hatchery and the fishermen in Albemarle Sound. They provided in that law that the fishermen could only set nets on certain days and at certain hours.

Now I have been down there recently, and the men say they will obey the rule. I tell them if they would not help this hatchery and carry out the rules, I will make it so they cannot fish on this ground at all.

The shad industry certainly, in my opinion, depends upon a closed season, and the work of the hatchery. We have a closed season after the 20th of May. The experiments in our waters indicate that not many shad are hatched, before about the 10th of May. It takes a certain temperature of water for a shad egg to hatch, and we do not have it before that time, and a shad that lays its egg before that time might as well be taken. And if we have a closed season from the 20th of May on, it shuts the hatchery down. We have no fears for the future of the shad industry of North Carolina.

I was asked by one fisherman on one occasion to go out with him, as he wished to show me something. I went out in the boat with him about two miles on the spawning ground where he had left a lid over a pound net. It was on the twentieth day of May of this year. After he had dropped his pound net, he raised the lid, and I saw thousands and thousands of little shad from the moss and from the accumulation around the nets, hiding there from other fish. So we found that this is another good idea on the spawning grounds. They are going to put lids out there hereafter until the shad fry get old enough to protect themselves. I make these remarks merely to show something of our conservation laws, of which we are very proud in North Carolina, and to indicate something about the prospects of the shad industry in Albemarle Sound.

Mr. Snyder: When I made those remarks I was not aware that North Carolina had placed any restriction on the nets in Albemarle Sound. Some years ago we wanted a restriction placed on those nets on the spawning beds. After they made the restriction and permitted the fishermen to set about three or four hundred yards of nets and stay there by them, we had the good will of everyone on the place. Prior to that, the fish hatchery got less than a million eggs a year from gillers, but after that we ran it up to over a hundred million eggs a year. The good will of the fishermen was obtained and every fisherman co-operated in getting eggs. Later, I am told, this good will was lost.

Mr. Wm. C. Adams, of Massachusetts: We have had the shad question and certain of these questions discussed year in and year out for a long time. We are willing to do almost anything in Massachusetts—to spend any reasonable amount of money—if we can get co-operation from those localities where shad, comparatively speaking, are reasonably abundant, to do something of a constructive sort to populate our waters again with this fish. In looking back over the efforts of all hands interested in the last few years, I have a feeling that we are working along the long distance lines that will accomplish this result. This brings up one phase of our work—not only of the American Fisheries Society, but the other allied societies—and it seems to me that we ought to lay out some kind of extended program that will involve four or five, or even more, years of constructive effort. When I say this I do not mean to reflect in any way on the efforts of the past, and especially on the constructive efforts of the Bureau of Fisheries as put forth, but there is a great chance here for interest and co-operation and for co-operation with the Bureau of Fisheries. If, in working out such a program, it seems advisable to make the Bureau of Fisheries an agent to bring this thing about, we should get more complete co-operation with the states interested in this program, and the Bureau of Fisheries, so that we can lay out a plan that will get us salutary results.

As far as Massachusetts is concerned, we have the money and we have the desire, and we will be glad to back up any agency that will take hold of this thing and work it out. I believe that this Society can be a tremendous factor in that work, but it must be along the line of a permanent program placed in the hands of responsible agents, with a systematic checking up to see that eventually we get the results.

A STUDY OF THE EFFECTS OF CERTAIN OILS, TARS, AND CREOSOTES UPON BROOK TROUT

(Salvelinus fontinalis.)*

By Adrian Thomas,
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(From the Biological Laboratories of Clark University.†)

The era of the motor car has brought with it the demand for good roads. Woodblock, stone and asphalt streets are possible in our cities, but the cost of such materials is prohibitive of their use on suburban roads. Gravel alone does not wear well under the heavy traffic and it is necessary to find some material to aid in the building of good roads. Frequently tars and like substances have been employed in the treatment of gravel and macadam roads which improve their wearing qualities, and in many instances have proved to be satisfactory from the point of view of the highway-engineer and the motorist. Many heretofore waste products are being used as matrices in road construction and thus they attain commercial value.

Though many of these products seem to make good roads, complaints are often made by fishermen, and sportsmen too, that the tar from roads washes into streams and ponds during rains, thus killing the fish or driving them away. Several articles appear in the "Fishing Gazette" during the years 1912, '13 and '14, noting the scarcity of fish in certain streams and ponds, and attributing their absence to the toxic effect of road washings. While the fish themselves may not actually be killed by some of the tars, the larval forms upon which they feed are destroyed, thus forcing the fish to seek localities where they may find food.

Through the Office of Public Roads a number of samples of materials, used as "road binders" were obtained. Small amounts of these substances have been added to water in which trout were placed and the effects noted.

* The U. S. Bureau of Fisheries provided the funds for pursuing these experiments and this is published by permission of the Commissioner.

† The author wishes to thank Prof. R. S. Lillie, of Clark University, for placing at his disposal equipment for this investigation.

No difficulty was experienced in keeping the fish during experiments. Trout fingerlings* were used and during experiments were kept in battery jars containing 1500 cc. of water to which the substance in question had been added. The water was aerated by means of a constant stream of air being passed through it. The experiments were performed in an unheated room and in very cold weather freezing of the water was prevented by heating the air before passing it into the jars. The air supply was obtained by connecting a filter pump with a bottle having two outlet tubes, one extending to the bottom, through which the water was forced out, and one from the top through which the air was distributed to the jars. When necessary to heat the water the air was passed through another bottle in which there was an electrical heating unit, before admitting to the jars containing the fish. A thermoregulator was connected with the heating unit and placed in one of the jars which prevented the temperature exceeding 15° C. In control experiments where no tar was added to the water the the fish would remain in a perfectly healthy condition for weeks. The only disturbing influences were the products of metabolism, and growth of bacteria. These were eliminated by renewing the solutions once a week during cold weather, and after each feeding in warmer weather.

The trout were fed on chopped liver. Those in the tank where the stock was kept never refused food, but those in the jars to which some of the tars had been added refused food at times.

Some of the substances were extremely toxic to fish, others less so and some had no effect. The degree of toxicity seemed to depend, in most cases, largely upon the degree of solubility in water.

Following are some of the results obtained in experiments in which the samples sent from the Office of Public Roads were used. The description of the samples is that obtained from that office.

"No. 5899 consists of some of the higher boiling distillates of petroleum, flash point 148° C., burning point 178° C., presumably obtained from Indiana or Illinois crude petroleum."

* Through the courtesy of the Massachusetts State Fish and Game Commission, the trout were secured from the State Hatchery at Wilkinsville, Mass.

As much as 500 parts of the above oil added to 1,000,000 parts of water showed no effect upon the fish. The oil, however, emulsified with the water after the air had kept it in constant motion for several days. After this emulsification took place the fish refused to eat (about seven days). The fish would then die in a few days, partly because of lack of sufficient food, and more directly because the gill membranes became coated with the emulsion. If the solutions were not areated the oil would not emulsify and the fish lived well provided the water was changed often enough to insure sufficient oxygen.

"No. 5907 is a crude water-gas tar obtained from our local gas company. It is produced by decomposition of petroleum products for the enrichment of carbureted water-gas. This particular sample is free from water and consists of benzol, toluol, a small amount of naphthalene, and numerous other high-boiling hydrocarbons of the benzene series."

In a mixture of 66 parts of tar to 1,000,000 of water the fish began to dart immediately and showed irritation of the gill membranes. The following experiments may be cited to show the degree of toxicity of such a mixture:

Experiment 5907–1.

No. of fish: 1.

Used: 0.1 cc. tar No. 5907; 1500 cc. water. (*i. e.*, 66: 1,000,000).

Put in solution 10:12 A. M., October 23, 1914.

Fish began to dart at once showing irritation of gill membranes. Put in water containing no tar at 10:20 A. M. Began to revive by 10:30 A. M. Jumped out of jar but was replaced apparently uninjured. Began to swim normally by 11:30 A. M. Put back into tar solution at 5:00 P. M. Removed to water containing no tar at 5:05 P. M. Was at this time in same condition as at 10:20 A. M. By 5:20 P. M. no improvement was shown—nearly dead. Observed at 10:00 P. M. and found dead.

Experiment 5907–2.

No. of fish: 1.

Used: 0.02 cc. tar No. 5907; 1500 cc. water. (*i. e.*, 13.3: 1,000,000).

Put in solution 10:13 A. M., October 29, 1914.

Showed signs of irritation at once. 11:15 A. M., body showed faint pink coloration. Swimming on back 2:00 P. M. On back at bottom 3:00 P. M. Transferred to water containing no tar.

Put back in tar solution 9:15 A. M., October 30. Again removed to water containing no tar at 1:20 P. M. Continued to swim on back and dart occasionally. Put back in tar solution November 2, 5:00 P. M. Dead November 3, 6:00 P. M.

EXPERIMENT 5907–3.

No. of fish: 1.

Used: Trace* of tar No. 5907; 1500 cc. water.

Put in solution 5:37 P. M., March 2, 1915. March 13, solution renewed; fish sick. March 14, swimming on back, 1:00 P. M. March 15, 9:00 A. M., nearly dead. March 15, 6:00 P. M., dead. The fish showed signs of paralysis just prior to death.

"No. 5962 is said to be a product obtained as sludge in treating certain petroleum distillates with alkali after the sulphuric acid treatment. The sample shows 2.43 per cent of alkaline ash upon ignition. The presence of this alkali renders the material readily miscible with water in the form of an emulsion, although this emulsifying character is lost to some extent when the material has been exposed to the atmospheric influences for some time. The product is obtained in the refining of Texas petroleum."

Fish subjected to water to which traces of the tar had been added showed no effect after 19 days when the experiment was discontinued. 66 parts : 1,000,000 of water caused death in about 36 hours. 13 parts : 1,000,000 of water caused death in about three days.

"No. 6122 is said to have been produced by dissolving about 40 per cent oil asphalt in some high boiling petroleum distillate. It was presumably prepared from products obtained from Illinois crude petroleum."

66 parts : 1,000,000 of water caused death in about three days.

13 parts : 1,000,000 of water caused death in about three days.

Trace of tar had no effect in 19 days when the experiment was discontinued.

"No. 6550 is a Mexican crude petroleum having a flash point of 26° C., and a burning point of 53° C. It has a loss of 27.68 per cent in the standard volitization test and, through the loss of lighter materials contained in it, sets up quite rapidly when applied to a road surface."

* A trace of tar was obtained by dipping a match stem into the tar and then into the water. A thin, irridescent film on the surface could be seen.

As much as 265 parts : 1,000,000 of water did not affect the fish in thirty-two days.

666 parts : 1,000,000 of water showed no toxic action in ten days.

"No. 6979 is a refined coal-tar product as a residual after removing some of the lower boiling distillates from crude coal tar. It consists of a mixture of benzene hydrocarbons of various boiling points and yields practically no distillates under 170° C. It contains 14.6 per cent of organic matter insoluble in carbon disulphide."

66 parts : 1,000,000 caused death in less than twenty-four hours. Upon examination, the fish killed by this tar showed congestion of the intestines.

13.2 parts, or less : 1,000,000 of water did not affect the fish in thirteen days, after which the experiments were discontinued.

"No. 6980 is the crude coal tar from which No. 2979 was prepared. It was obtained in the manufacture of coal gas from bituminous coal in Salt Lake City."

330 parts : 1,000,000 of water caused death in seven hours.

100 parts : 1,000,000 of water was harmless after thirteen hours of exposure of the fish to this mixture.

"No. 7014 consists of a mixture of low-boiling distillates and semi-solid asphalt obtained from Texas petroleum. It has a flashpoint of 35° C., and burning point of 55° C."

165 parts : 1,000,000 of water was harmless in thirteen days.

"No. 7057 is an oil asphalt presumably prepared from a mixture of Texas and Mexican crude petroleum by distilling off the lighter components and possibly agitating the residue with air to some extent." (This product is a solid.)

6660 parts (by weight) : 1,000,000 of water proved non toxic.

"No. 7819 is produced from a crude material similar to No. 5907 by removing some of the lower-boiling constituents. This particular sample contains considerable napthalene."

66 parts : 1,000,000 of water caused death in three days.

33 parts : 1,000,000 of water caused death in ten days.

A trace appeared to be non toxic.

"No. 7058 consists of a mixture of Bermudez native asphalt with some form of petroleum flux." (This product is a solid.)

6660 parts (by weight) : 1,000,000 of water proved non toxic.

The crude oils and asphalts caused no toxic effect at all. In the case of the former no toxic substance is thought to be present, in the latter case the substance is in the form of a solid, insoluble mass. Gas house products were somewhat soluble and exceedingly toxic.

In many cases of road construction the gravel is spread, rolled, and the tar is then sprinkled over the surface by means of a sprinkling tank similar to those used for watering the streets. In many cases but little attention is paid to the condition of the ground or to the weather. The writer has seen roads being oiled during periods when rains were frequent and the roads were moist. Under these conditions of spreading, the tar has been noticed along the sides of the roads where it had been washed by the first rain after laying.

It has been observed that when roads are tarred during the course of construction, the tar being distributed throughout the whole bed and not only over the surface, and a thin layer of sand spread after the final treatment with tar, no appreciable amount washes away unless there is considerable rainfall during the first day or two after treatment.

A sample of concentrated waste sulphite liquor was obtained from the Office of Public Roads. It is obtained by concentrating the crude liquor obtained in the manufacture of paper pulp by the sulphite process. It is used quite extensively in the treatment of macadam and gravel roads. This sulphite liquor is freely soluble in water to which it gives a color varying from a light straw to a dark brown, depending upon the concentration.

Fish placed in solutions of 333 parts : 1,000,000 parts of water were not killed in two weeks yet at times they would show some signs of distress. Fish died within two weeks in solutions of 1333 parts : 1,000,000 of water. Though they did not show typical signs of poisoning, as the fish killed by other materials did, they were doubtless killed by this concentration of the waste. Some irregularity of the effect of the liquor upon fish in different experiments was noted. Marsh* has noted this and attributed it to individual variation.

*Marsh, M. C.; Effect of some Industrial Wastes on Fishes: The Potomac River Basin, Water-supply and Irrigation Paper No. 129, Government Printing Office, 1905.

Levy* notes that fish are reported to be affected by sulphite liquor wastes from paper mills. It is said that when the waste is emptied into streams, where fish are usually caught, the fish will not bite, but if the pollution is stopped for a period, good catches are made until the stream is again polluted. This Dr. Levy points out would tend to show that the fish were present all the time but refused to bite in the polluted water.

During the experiments it was noted that the fish would not feed in solutions of the sulphite liquor, but if taken from them and placed in pure water at intervals for a few minutes they would eat ravenously. Though this waste may not be termed toxic in the strictest sense, the fish certainly do not thrive in it. The evidence gathered shows that washings from roads treated with this substance, though they would not kill the fish perhaps, would tend to drive them to another locality free from pollution.

Water gas tar proved extremely toxic. A sample obtained from Providence, R. I., killed trout in thirty hours at a concentration of two and a half parts per million. In several cases the fish behaved not unlike they did in water to which creosote has been added. This behavior will be mentioned later.

A sample of light fuel oil was obtained from the Division of Fly and Mosquito Suppression of the Brookline, (Mass.), Board of Health. This oil is used to destroy and prevent mosquito larvæ in pools and the like. The oil was found to be non toxic. It emulsified upon aeration as did the sample of oil No. 5899 from the Office of Public Roads. After the oil had reached this state it coated the gill membranes. In experiments where the water was not aerated no emulsification took place and the fish appeared to be in a perfectly healthy state and would feed regularly. No signs of distress were shown at any time provided the water was renewed often enough to prevent asphyxiation.

Creosotes are used extensively as preservatives for wood that is to be immersed in water. Fishing nets are also "cured" at times by means of creosote. An article on "Net Curing by Creosote" appeared in the *Fish Trades Gazette*,† in which attention

* Levy, E. C.; Report to the Water Committee in the Investigation of the Effect of Trades Wastes on the Waters of the James River at Richmond, 1905.

† Fish Trades Gazette (London) vol. xxxl, No. 1606, Feb. 28th, 1914.

was called to the fact that fishermen in the vicinity of West Cornwall were in the habit of curing their nets by steeping them in creosote "green oil," and subsequently passing them through a wringing machine, thus leaving a minimum of oil. They were then dried for some weeks and then given two or three treatments with "cutch." After this treatment it is stated that no creosote could be detected. To quote: "Today, however, the treatment is vastly different, with very few exceptions; whole long trains of nets are shot out that have only a few days previously been taken out of barrels or other receptacles, in which they have been steeped in the "liquid," so that probably on the initial night of the season, with a fleet of sixty drifters casting out their trains, some hundreds of gallons of oil have been washed out, and has a tendency to permeate the water for some miles."

The flesh of fish caught in these nets would undoubtedly taste more or less of creosote, as this substance permeates very quickly, and the oil permeating the water would tend to drive the fish from the fishing grounds.

In the same article experiments conducted by J. E. Allen are cited. He found that the "green oil" at a dilution of one part per 1,000,000 parts of sea water would kill young swimming prawn, (heimysis) within an hour. An experiment is cited where twenty-five prawn were put in a solution of one part in 10,000,000 parts of sea water. Half were dead in twenty-five hours, three-fourths in two days, and all in five days. A control experiment showed no deaths at the end of six days.

Several samples of creosotes were obtained and small quantities of these added to water containing fish proved to be extremely toxic. The action of the creosotes on fish was very marked. In most cases when put into solutions of 13 parts per 1,000,000 of water the fish immediately began to dart violently. The gill movements were rapid at intervals, though at times the gill movements were abnormally slow. At other times the slow and rapid movements alternated for some time. In many cases the fish began to swim rapidly on their backs. At other times a gyratory movement was noticed.

Light and dark spots were noticed over the bodies. Ordinarily upon death the fish were of a fairly uniform color over the entire body, but when death was caused by very toxic solutions of

creosotes, dark spots covering half of the body were observed. In one or two cases the action of one or more fins was inhibited, and in general the nervous system appeared to be greatly affected. Fish in solutions of creosote would at times live for days with apparent loss of motor control. They would remain on their sides or backs practically motionless except for gill movements. At times the fish would quiver over the whole body, but were unable to swim or control their movements. When taken from solutions of the creosotes and put into pure water the fish would in many instances regain normal movements and to all appearances recover. The effect of the creosotes and like materials is so marked that behavior due to their presence cannot easily be mistaken.

The toxicity of creosote solutions may be seen from the following experiments in which fractional distillates of commercial creosote were used. One fish was used in each experiment.

FRACTION DISTILLING UP TO 205° C.

Exp.	Amounts Used		Concentration parts per million	Result
	Water	Creosote		
1	1500 cc	Trace	Trace	No effect in 21 days.
2	1500 cc	0.1 cc 1% solution*	0.6	No effect within 19 days.
3	1500 cc	0.02 cc	13.2	Died in 33 hours.
4	1500 cc	0.01 cc	6.6	Died in 21 hours.
5	1500 cc	0.05 cc	33.3	Died in one and two-thirds hrs.
6	1500 cc	0.05 cc	33.3	Creosote was put in water and aerated for four days before fish was put in. No toxic effect was noticed and the experiment was discontinued after seven days.

* A 1% solution was obtained by shaking 1 cc of the creosote with 99 cc of water.

FRACTION DISTILLING BETWEEN 205° C. AND 250° C.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic. After 11 days 0.02 cc creosote added. Gill movement became rapid. Dead in less than 12 hours.
2	1500 cc	0.02 cc	13.3	Helpless on back at bottom in 5 minutes. Half of solution poured off and an equal amount of water added. Fish Recovered.
3	1500 cc	0.1 cc 1% solution	0.6	Non toxic within 19 days.
4	1500 cc	0.01 cc	6.6	Solution changed every 7 days for 21 days. Fish sickened each time solution was renewed but recovered each time. Discontinued exp.
5	1500 cc	0.02 cc	13.2	Swimming on back after 3½ hours; recovered after about 24 hours. Discontinued after 5 days.
6	1500 cc	0.02 cc	13.2	Creosote put in water and aerated for 4 days before fish was put in. No effect noted within 11 days, when experiment was discontinued.

FRACTION DISTILLING BETWEEN 250° C. AND 295° C.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic. After 11 days 0.2 cc creosote added. Dead in 15 hours.
2	1500 cc	0.1 cc	66.6	Dead in six days.
3	1500 cc	0.1 cc 1% solution	0.6	Began to dart immediately, but recovered. Discontinued in 3 days.
4	1500 cc	0.02 cc	13.2	Showed distress in 3 hours. Recovered in 2 days. Discontinued after 5 days.
5	1500 cc	0.02 cc	13.2	Solution aerated for four days after creosote was added. Fish then put in. Swimming on back four hours. Recovered in two days. Discontinued after eleven days.

FRACTION DISTILLING BETWEEN 295° C. AND 320° C.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic. After 4 days 0.2 cc creosote added. Dead in 7 hours.*
2	1500 cc	0.01 cc	6.6	Dead in four days.
3	1500 cc	0.1 cc 1% solution	0.6	Dead in four days.
4	1500 cc	0.02 cc	13.2	Dead in 24 hours.
5	1500 cc	0.02 cc	13.2	Solution aerated for 4 days before fish was put in. No effect. Experiment discontinued after 11 days.

* Gills showed rapid movement at once.

RESIDUE AFTER DISTILLATION AT 320° C.

Exp.	Amount Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	Non toxic.
2	1500 cc	Trace	Trace	Non toxic. After 7 days 0.02 cc creosote added. Dead in about 12 hours.
3	1500 cc	0.1 cc 1% solution	0.6	Non toxic.
4	1500 cc	0.02 cc	13.2	Had shown no effect up to end of second day when fish escaped from jar.

COMMERCIAL CREOSOTE FROM FORREST PRODUCTS LABORATORY, MADISON, WIS.

Exp.	Amount Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	No effect in 7 days. 0.02 cc creosote added to water. Fish began to dart at once. Soon at bottom; motionless except for gill movement after a few hours. Recovered and swam freely in two days.
2	1500 cc	0.1 cc	66.6	Practically dead in three hrs.
3	1500 cc	0.1 cc 1% solution	0.6	No effect within 2 days after which fish escaped from jar.
4	1500 cc	0.4 cc	266.6	Dead in eight hours.
5	1500 cc	0.4 cc	266.6	Solution aerated for 4 days before fish was put in. Fish swam on back on second day. Somewhat recovered on 3rd day. Dead on 4th day.

CREOSOTE FROM COAL TAR.

Exp.	Amounts Used		Concentration parts per million	Results
	Water	Creosote		
1	1500 cc	Trace	Trace	No effect in 7 days. 0.02 cc creosote added to water. Began to dart immediately. Dead in 30 minutes.
2	1500 cc	0.01 cc	6.6	Darted occasionally; escaped in six days.
3	1500 cc	0.1 cc 1% solution	0.6	No effect within 19 days.
4	1500 cc	0.02 cc	13.2	Dead in about 40 min. Another fish put in same solution. Dead in 30 hours.
5	1500 cc	0.02 cc	13.2	Solution aerated for 4 days before fish was put in. Dead in 12 hours.

It can easily be seen that except when in mere traces most of the creosotes are highly toxic. In experiments where the water containing the creosotes was aerated for a few days before the fish were put into it, the fish lived much longer than when put in before aeration, thus showing that aeration had decreased the toxicity. When a second fish was put in a solution in which one had previously died, it would live longer than the first fish. This may have been because some of the creosotes had been absorbed by the fish first placed in the solution, thus the concentration reduced, or the toxicity may have been decreased by aeration. Fish from creosote solutions had a strong odor of the oil. The flesh even after being cooked, tasted of creosote.

To ascertain the effect on fish of wood after treatment with creosotes the following method was employed. Strips of wood about one square centimeter cross-section were painted with a thick coat of creosote and hung to dry in an unheated room for nineteen days. The temperature of the room, observed during the day, ranged from about 10° C. to about 20° C.

After drying, the strips of wood were anchored in jars of water, where they assumed a position not unlike that of spar-buoys. The anchors were made by sealing mercury in glass tubes. These were tied to the strips of wood by means of cotton cord. In this way no metal or other interfering substance was introduced into the water. The painted surface of the strips exposed to the water was about thirty or thirty-five square centimeters.

The strips were weighed before and after treatment with the creosote and also after drying. From two to five-tenths of a gram of the creosote adhered to each strip, depending upon the viscosity of the individual substance. From a half to an eighth of the weight of the creosotes was lost upon drying.

The strip treated with creosote from coal-tar killed the fish is about twenty hours. The one treated with the product distilling between 295° C. and 320° C., killed the fish in three days. The others produced no effect at all upon the fish in a week. The fish did not refuse food either.

A possible cause for the death of the fish in the two instances mentioned might have been that the creosotes had not thoroughly dried and hardened before the strips were immersed in water. Time did not permit repetition of the experiments.

The effect of aeration on the various substances used was not always the same. It would appear that the aeration increased the toxicity of crude oils. Sample No. 5899 as noted before did not appear to effect the fish because of its chemical nature, but after continued aeration emulsification occurred and the resulting emulsion then coated the gill membrane, preventing proper respiration. This, however, must be looked upon as merely a mechanical change, due to the constant agitation of the oil and water as the air passed through it. Comparatively large bubbles were employed in aeration as the outlets of the aeration apparatus were pinholes in the ends of glass tubes, thus the contents of the jars was constantly stirred.

In a few experiments in which the light fuel oil obtained from the Brookline, Mass., Board of Health, was employed; the water was not aerated, but changed as soon as the fish began to show any signs of insufficient oxygen supply. As has been before noted, the fish fed regularly and no signs of distress were shown. Controls, using fish of about the same weight, and employing the same volume of water having the same surface area exposed, showed that the oil-film caused little, if any, difference in the amount of oxygen absorbed from the atmosphere. The oil did not form a continuous film over the entire surface of the water, but had a tendency to form films at intervals, thus leaving considerable of the surface of the water directly in contact with the air.

It is very doubtful if, in the small amounts used in mosquito campaigns, the oil would effect the absorption of oxygen from the atmosphere by the water.

In cases of some of the creosote solutions, aeration decreased their toxicity. This is probably due to an oxidation of the oils themselves.

When tars, in drainage from roads, are carried into the streams, such drainage undergoes active aeration and agitation sufficient to cause emulsification of oils similar in nature to the crude oils used in the experiments. The small volume of such an emulsion entering a stream would scarcely be sufficient to affect the fish for the effect is undoubtedly a mechanical one in that the emulsion coats the gills and inhibits respiration, or else coats the food of the fish, causing them to ignore it. The emulsion being less dense than the water, would tend to be carried off on the surface in a

short space of time. It is believed that only the tars and oils which are of a toxic nature chemically would affect the fish when washed into streams by rains.

The problem of creosotes is chiefly to be met with where wood that is to be submerged in water, is treated with them; or where nets are so cured. It is thought that by allowing the wood to dry for a sufficient period before placing in water will greatly prevent detrimental results.

SUMMARY.

Products from gas works, and coal-tars containing substances somewhat soluble in water, were found to be exceedingly toxic to the fish. This is probably due to the fact that they contain some soluble substances, such as phenols and like compounds.

Crude oils and asphalts caused no toxic effect except that the crude oil would emulsify upon continued agitation and, if in the water in large proportions, finally coated the gill membranes of the fish thus inhibiting respiration. This is purely a mechanical effect, such as is unlikely to occur in streams or ponds.

The concentrated waste sulphite liquor, as obtained, did not kill the fish when added to the water in only small amounts, yet in these dilute solutions the fish would at times show signs of distress and were killed by higher concentrations. The results obtained tend to show that the presence of this material in natural water would cause the fish to seek an unpolluted locality.

Creosotes when added to water proved to be highly toxic. Aeration somewhat diminished the toxicity probably by the oxidation of the products themselves. In all but two cases wood treated with creosotes and then dried did not affect the fish, and in those two cases the toxicity has been greatly reduced by the exposure to air.

Discussion.

Mr. W. E. Barber, of Wisconsin: The Wisconsin Conservation Commission has had a great deal of trouble with paper mills discharging their wastes into the streams. We have an instance where a gas plant dumped its industrial wastes into the river. In the case of the gas plant, septic tanks were ordered put in. Those tanks were filled with gravel to half their depth, and all of the wastes from the plants were deposited in them. There was an outlet from one tank into the other, and then it led to the river. After those tanks were put in under proper construction we had no further difficulty with the gas company. But with the paper mills we have had untold difficulty. We found that some of the plants deposited all of their industrial wastes into the river—the wood pulp, the bark, and all of the refuse. There are sixteen plants located on one river in a distance of about 150 miles, and it is driving the fish entirely out of that river, as you all must well know. They are ordered to put in filtration plants. The waste is to be filtered through coke, and from that into two septic tanks, and from that drained into the river, all of the heavy wastes to be returned to the plants and used for fuel. The paper mills are only too glad to co-operate with the officers in constructing the necessary equipment for taking care of their wastes.

Another difficulty we have had is with the pea canning plants, of which there is a great number in the state. The seepage from these which is very poisonous, has been draining into some of the trout streams. Tanks to take care of all of the poisonous matter have been ordered, and this has been conformed to by practically all of the plants of our state that have been depositing their waste in the streams. The difficulties that we have had with the paper mills have arisen mostly because we have had no law in the state until last year prohibiting the deposition of their industrial wastes in the streams.

The paper mills thus encounter an expense of about $2500 to $3000, but they are all very willing to co-operate, as I said, and we believe that if other states are having the same difficulty—and no doubt some of them are—this system will remedy the situation.

Professor E. E. Prince, of Ottawa, Canada: Mr. Chairman, I have taken a great interest in this paper, because in Canada we have had a number of tests made, and we were rather disappointed to find that in many cases the refuse brought into the rivers did not prove fatal to the fish. I have no doubt it affected feeding conditions, but we found very rarely that the fish died from the poisons from gas works, etc., doubtless due to the fact that rapid oxidation took place in the rapid running water. But the point I want to emphasize is this, that undoubtedly polluted water, in the case of salmon, will turn away fish. I have had a particular case before me as Commissioner of Fisheries in Canada, lately in North New Brunswick. A certain river has for a season or two showed very serious deterioration. The fish undoubtedly came to the mouth of the river, turned about there, and evidently were deterred on account of the amount of wastes which has

been poured in within a few miles up the river. The only explanation has been that the fish have been turned away, because they have appeared very universally in neighboring rivers. Instead of going into their own river, they were turned away by the flavor of the water, as it were.

Mr. Thomas: I am very glad indeed to hear what Doctor Prince has to say. Having investigated nearly a dozen cases in the state of Virginia during the past year, I received reports, each time before I made the investigation, that thousands of fish had been killed by a certain pollution, but only in one instance did I find any evidence of fish having been killed. It seems they are simply driven away, and seek other localities. Fish above the source of pollution are as numerous as ever, and some miles below the source of pollution fish begin to show up, according to the amount of pollution which is poured into the water, and they increase as you go further down stream. In only one case have I noticed recently where any number of fish were killed, and that was from a furnace and iron works where the fuel gases were washed before being used as fuel. These gases contained prussic acid, and I found as much as thirty parts per minim of prussic acid in the water which was sent into the stream. Of course that did kill the fish, and very quickly, inside of forty-eight hours after the furnace was started. We have had no fish in that stream since, but are taking every step to prevent any more prussic acid being poured into the water; but that is the only instance that has come to my attention where any great number of fish have been actually killed by pollution.

Dr. R. C. Osburn, of Ohio State University: I wish to ask Mr. Thomas if, in the course of his experiments, he has noticed any difference in the toxic effect of these substances at different temperatures. It occurred to me when Dr. Prince was speaking that possibly the lack of effect, or slight effect, which he noticed might be due to the lower temperature of the water in Canada, as we know that many substances have less effect at lower temperatures.

Mr. Thomas: I have not sufficient data to publish it, but my investigations showed that with higher temperatures, tars and creosotes affected the fish much more readily. I am almost forced to believe that it is due to the solubility of these substances in the water at higher temperatures. With oils undoubtedly the temperature has considerable to do with toxicity. I tried to run these experiments with a variation of five or ten degrees. I have not had an opportunity to continue the study with reference to temperature changes, but preliminary experiments show that undoubtedly the temperature is a great factor in producing a toxic effect. In cases of ordinary pollution I do not believe that the temperature would have very much effect.

Mr. W. E. Barber, of Wisconsin: It seems that we have a proper diagnosis of the disease, and now what we want is an absolute remedy for this pollution. We have discovered that where the deposits from the pea canneries enter our rivers and streams the fish are killed. The paper waste seems to drive them away. We do not find dead fish, but there are no fish

there to be caught. What we want is to know just what ought to be done as a remedy.

(In reply to questions by Mr. Titcomb and Mr. O'Malley, Mr. Barber replied that the Wisconsin law absolutely compelled the paper factories to keep poisonous wastes out of the streams and that the system of prevention is just being installed this year.)

Mr. G. C. Leach: Sometimes deleterious substances are turned into the streams inadvertently. For instance, out through the west, where they have so many stamping mills, cyanide is used and sometimes it will moisten the tank and get into the streams. Of course it usually kills all the fish in the immediate neighborhood until it passes down the stream and becomes diluted, and it is not always through the fault of the companies having the plants.

Mr. M. L. Alexander, of Louisiana: We have been giving this matter some attention down south, and have ample law, as far as that is concerned, to cover it. The large paper mills recently erected there, costing several millions of dollars, take ingredients out of pine trees. The matter that comes from those mills has discolored the water very much, but I found that it has not killed the fish, nor affected it for drinking water for stock. However, we have had these people run their water as far as possible out into the streams and across the sand bars, to give it a filtration process.

Another large industry down there is the distillation of pine stumps, a sort of alcoholic distillation that seems to be very poisonous indeed. The particular factory that I investigated has poisoned the stream on which it is located for about twenty-five miles, and the water was even poisonous to stock—a very serious problem. I had the manager come down from New York, and they are now trying to perfect some system that will correct this, though it will cost them a good deal of money.

The most serious trouble, however, that we have on our bayous and streams in that low country is the poisonous matter that comes from the sugar refineries. The manufacture of sugar is one of our greatest industries, and great numbers of these refineries are located along the bayous and streams, and during the period of their operation they unquestionably kill the fish through the acids that come from the waste matter from those mills. We have made a general survey of the situation and have tried as far as possible to run this matter off through the swamps, but it comes back into the streams.

We have absolute authority under the law to close down these factories that poison the streams, but to close them down would mean the destruction of the entire sugar crop that has to be harvested in a very short space of time, about fifty days. If we put these drastic laws into effect it will destroy the crop of sugar, which the Government particularly needs at this time. Louisiana is producing 85% of the cane sugar of the United States. We cannot do it, so we have to let them kill some of the fish.

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THE PROTECTION OF POND EMBANKMENTS AGAINST WAVE ACTION.

By H. L. Canfield,
Supt. of Fish Culture, U. S. Biological Station, Fairport, Iowa.

Much difficulty has been experienced in maintaining pond embankments against wave action and many crude as well as pretentious devices have been resorted to in an attempt to satisfactorily cope with this problem.

Of the methods available, rip-rapping is known to be effective and is used in certain cases, but the expense involved is prohibitive for general use and this construction provides a harbor for crayfishes and various other fish enemies and is not favorable to the production of food for fishes, therefore, it is regarded as generally unfavorable by fish culturists. Willows will hold the embankments, as will some of the rushes, but these cannot be controlled, and are not considered satisfactory for general use about ponds, although they are of benefit as a protection against wave action under certain restricted conditions.

The demand for a satisfactory method of combatting destructive wave action, especially in connection with fish cultural operations, has been indeed pressing.

It is unnecessary to quote figures on the upkeep of pond embankments to emphasize the importance of the subject, but as an example of the extent to which persons have expended money and labor in an attempt to meet this problem, the experience of Mr. W. T. Marr, of Ainsworth, Iowa, will be given. Mr. Marr has a farm fish pond of about 1 acre in area and the wave action on the embankment at the outlet of the pond (which is about one-fifth of the circumference) gave so much trouble and required so much labor in repairing, that he decided to build a cement abutment to meet the situation, which he did at a cost of $100.00. This was about five years ago. When winter came on, however, the ice cracked the abutment in several places and it settled into the pond, so two years ago Mr. Marr placed a heavy fence of two-inch planks just over the cement abutment which, he estimated, cost him an additional $100.00, making in all $200.00 expended in

an attempt to provide a satisfactory embankment protection, not counting the cost of upkeep in the meantime. He now states that he has to frequently fill in back of the fence with dirt to replace that washed out between the abutment and the planks. Thus, after the outlay of much labor and expense, he is anxious to procure a satisfactory preventive against destructive wave action and intends visiting the station at Fairport, Iowa, to learn our method first-hand, with a view to using it on the embankment of his pond.

The problem of prevention of wave action against pond embankments in relation to fish culture is primarily to provide something that will bind the soil; serve as a breaker against wave action; be easily controlled; inexpensive to introduce, and generally favorable to fish life. All of these requirements are met and additional benefits to be had by establishing at the water line of pond embankments a sedge, common in middle west lowlands, where it is known as wire-grass, sour-grass, etc., the scientific name of which is *Carex stricta.*

Carex stricta is a tough, fibrous sedge with numerous lengthy fibrous roots and stolons which grow in abundance and serve to securely tie embankments. It grows to a height of four and one-half to five feet and continues through the summer until late in the fall. By reason of its tough, fibrous texture and abundant growth, a protective "mat" is then formed, which is effective against wave action throughout the winter and early spring. The sedge does not "winter kill," whether the ponds are filled or empty, and the young shoots break through the ground early in the spring. It has a tendency to grow up the embankment rather than around the pond, and only penetrates into the water in very shallow places. There are over 1000 sedges of various types, several of which are useful for protection of pond embankments, but *Carex stricta* is found to be especially desirable for the purpose. To emphasize the tough fibrous nature of this sedge, it may be mentioned that this variety and several other sedges are consumed in large quantities in the manufacture of the so-called "Crex," or grass, rugs, and also in the manufacture of binder twine.

Carex stricta has been successfully used as a preventive of wave action against fish pond embankments for the past six years under trying conditions and this test, coupled with a series of experiments

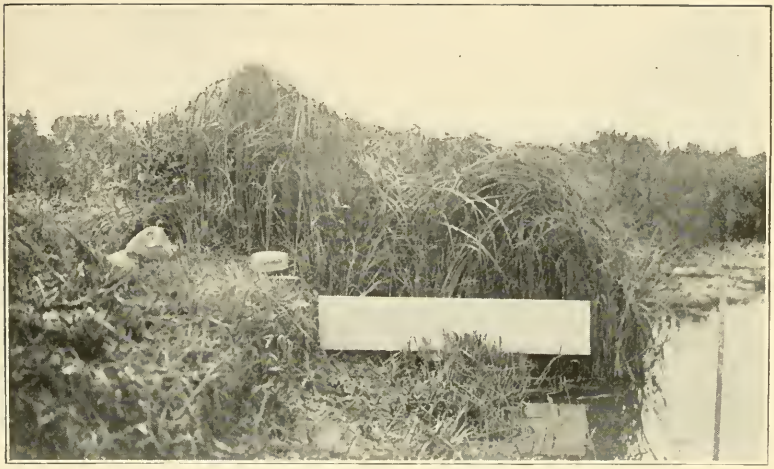


FIG. 1. Pond No. 3, Series D.

Stake to right indicates original edge of embankment; center of cardboard, base-sod line; left end of cardboard, where washing was checked. The waves had cut into this bank six feet, but was stopped immediately by *Carex stricta* sod.

FIG. 2. Trimmed and Untrimmed Sedge.

This sedge joins that shown in photo above.

(Photos by J. B. Southall.)

FIG. 3. *Carex stricta* Sod.
Left, stolon ready for planting; right, result after one year.

(Photo by J. B. Southall.)

at the U. S. Fisheries Biological Station, Fairport, Iowa, in growing and transplanting, justifies its recommendation as an efficient and satisfactory preventive of wave action against pond embankments and especially so in connection with fish cultural operations. The sedge furnishes shade and a place of refuge for fishes. Insects are attracted to the ponds by it, and its submerged parts provide a harbor and breeding place for aquatic life, all of which stimulates the production of fish food, adding to its value as a binder for fish pond embankments.

Attention is called to photograph No. 1, which was taken of Pond No. 3, Series D, for the purpose of showing the *Carex* sedge in use. This embankment was cut down for a distance of six feet by wave action and was being steadily washed away until suddenly and permanently checked by the planting of *Carex stricta* sod. The stake to the right indicates the inner edge of the original embankment. The clearing presents a view which shows the line of the *Carex* sod as originally laid; the general appearance of the sedge growing about the pond and the distance it has grown up the embankment and into the water since the time of the original planting which was four years ago. Since the day of the introduction no perceptible washing of the embankment has occurred.

Photograph No. 2 shows the *Carex* from the water to the top of the embankment. The water line and embankment may be beautified if desired by trimming the *Carex*. Photograph No. 3 shows a stolon (left) ready for planting; at the right the result after approximately one year's growth.

METHODS OF INTRODUCTION.

The sedge has been grown from seed at the Fairport Biological Station, but this method of introduction is not recommended for two reasons. First the expense of collecting the seed is excessive, because the sedge produces only a very limited amount. Second the seed was found to thrive in moist soil, but failed in wet and dry soil, consequently, the waves washed out the seed before it established itself in any but protected places. The quickest and therefore the most efficient manner of introducing this sedge is to transplant the sod from the wild state to the pond, laying it in a line around the pond on the base formed by waves, care being

taken not to allow the tops of the sedge to be submerged. A safe rule is to lay the sod so the top of the dirt is a little above the water surface and maintain this level for about a month or until the sedge becomes attached.

Where the sedge is not available close at hand the stolons may be collected or purchased and shipped to any point desired. By gathering the stolons and transplanting them to the inside border of the base formed by wave action, care being taken not to allow the tops to be submerged, a very satisfactory growth may be obtained the first year. The result will, however, be proportionate to the care with which the stolons are planted and given opportunity to take root. The tops should not be allowed to hang in the water or the water to be quickly raised, thus disturbing the plants before they become established, as the sedge must have air above the water and will be killed out by submerging. By planting the shoots 3 inches apart a good stand should be obtained the first season and 6 inches apart gives a satisfactory stand, while one foot apart is the maximum distance that should be attempted. The stolons should be obtained for planting during May and June to allow as long a growing period as possible the first season. Any man familiar with setting out plants can do the work.

When the sedge is being introduced it is recommended that one entire pond border subjected to the greatest wave action be planted, the plantings being made reasonably close together to provide necessary protection as quickly as possible. As stated, the transplanting of sod is best because immediate results are obtained, but the planting of stolons is cheaper and when carefully done is very satisfactory.

When a new pond is completed and the water is turned into it, as it overflows, the wave action indicates the water line immediately by cutting a level base into the embankment around the pond. The prevailing direction of the wind determines the particular point of excessive wave action and if the wind is high much damage is done. Therefore, immediate protection must be provided new embankments until permanent methods are installed and a hastily constructed "boom" will meet the emergency effectively. This can be made of 2 x 4's, boards, timbers, old cross-ties or other available buoyant material, by attaching them end to end at a distance of a few inches apart by means of staples

and wire or rope. The "boom" should then be anchored from both ends near the sides of the pond at sufficient distance to maintain it two or three feet clear of the embankment receiving the wave action. Such a "boom" is also of value for use at rough points to protect newly introduced stolons until they take root.

SUMMARY.

1. *Carex stricta* is an efficient protection against wave action on pond embankments and is especially desirable in connection with fish cultural operations.
2. It binds and secures pond embankments by means of its abundant root system against seepage, heavy rains, etc.
3. It provides food for fishes above and below water.
4. It provides an avenue of escape for young fishes from their common enemies.
5. It is easily and cheaply introduced.
6. It provides shade for fishes.
7. It is a rapid grower and is easily controlled.
8. It beautifies pond embankments.

HATCHING FRY IN GRAVEL.

By A. Robertson,
Harrison Hot Springs, British Columbia.

INTRODUCTION.

In 1915 I was induced by the general decline in the salmon canning industry and more especially by the scarcity of sockeye salmon on the spawning grounds, and also by the doubtful success of the present hatchery system, to make some investigations and comparisons between it and the natural mode of incubation.

Very little investigation sufficed to show that naturally hatched fry were much superior in size and capability to the hatchery product, and also that this superiority was attained in less time, due to the prevalence of warmer water in the natural beds than that used in the hatcheries. This superiority was apparent even in the eggs; eggs dug up out of the gravel presented a florid and swarthy appearance, which was lacking in our hatchery eggs, and this indicated the presence of stronger embryos. When the fry had absorbed the sac the difference was still more pronounced, and particularly noticeable in the length of the gravel hatched fry which were approximately twenty-five per cent longer and fifty per cent heavier, and also in the size of the eye, which was from one hundred to two hundred per cent larger.

In strength and capability the difference was as between day and night; the wild natural fry hugged the shore singly or in very small schools, and when pursued made for a hiding place with frenzied erratic dashes. Hatchery fry when liberated swam aimlessly about, and only after repeated onslaughts of trout and ducks, during which they lost heavily, were they herded into shallow water and comparative safety. This condition of affairs is only to be expected, for the smooth sides and bottoms of hatchery troughs offer no inducement to the fry to seek hiding places, and their instinct in this respect is soon dulled. On the other hand, fry that have come from the gravel and darkness are movement and light shy in the highest degree.

Having demonstrated, to my own satisfaction, that there was room for great improvement, I have since then experimented in various ways to ascertain the good features of both methods, with the view of combining them.

Nature is prodigal and only the fittest survive, and this fitness is the only redeeming feature of natural incubation. The production of a greater number of fry from a given number of eggs, and the greater protection afforded these fry up to the time of liberation, are the strong points in favor of the hatcheries.

While it cannot be denied that the eggs, as laid by the female fish over an extended period of time, are more susceptible to virile impregnation, which never can be equalled by human agency, still it is doubtful whether the present methods of taking the eggs from the fish, when ninety-five per cent or over are fertilized, will ever be improved on and need not be discussed here. From this stage on, however, the divergence in procedure has great effect and the object of this paper is to point out the shortcomings and merits of both systems as they appear to me.

WATER CIRCULATION IN THE GRAVEL.

Spawning salmon seek out beds where seepage occurs and ignore seemingly suitable spots where this condition is lacking, and experiments in connection with this prove that eggs will not survive under the water without circulation.

I made four tubes of basket wire twelve inches long and one inch in diameter, filled them with eyed eggs, and buried them under one foot of water and one foot of gravel, with water running over them. After a lapse of four days I dug one up and found the eggs in an advanced state of suffocation, which, though not enough to kill, was sufficient to seriously impair the strength of the resulting fry. Each succeeding day I dug up another with increasing bad results, and that on the seventh day was ninety per cent dead. A tube of eggs, buried similarly, fifty feet away where the fish did spawn, hatched successfully. I also filled several glass jars six inches high with eggs, placing same under running water in a trough, and found that they died from the bottom up at the rate of approximately an inch per day, and eggs buried in gravel in a dish one inch deep, placed similarly, died in a week. This may

correct an impression that every gravel bar is a spawning bed and accounts for the partiality shown by fish for certain localities.

Seepage is not subject to the fluctuations in volume and temperature prevailing in surface water and is cleaner and more free from debris.

WATER CIRCULATION IN THE TROUGHS.

The circulation in hatchery troughs is indirect and is not conducive to the production of strong fry. The eggs are in a mass in the basket, which varies from one to two inches deep, and the water, following the path of least resistance, passes to a great extent under, over and by the sides of this mass. Even when fifteen to twenty gallons of water per minute and riffle dams are used, the eggs in the centre of a two inch mass are in a state of semi-suffocation, and killing is only prevented by shaking up. Eggs having all the appearances of suffocation may recover if thinned out or shaken up, but the effect of this semi-suffocation must be cumulative and must affect the strength of the resulting fry.

I spawned a number of eggs and placed a layer two inches deep in a hatchery basket subject to the normal water supply and riffle dams, and from the remainder I filled a whitefish jar full. Just before the eggs hatched I counted the number of eggs to the lineal metre several times from both basket and jar, and found that the jar eggs were at least five per cent greater in diameter. In the jar the circulation of water was direct; in the basket indirect; and while this test may not be conclusive, a straw shows how the wind blows and I intend going into it thoroughly this winter.

TEMPERATURE OF WATER IN THE GRAVEL.

Seepage, according to the distance it has traversed the earth, varies in temperature, ranging up to the temperature of so-called spring water, which is about forty-five degrees, and varies very little throughout the year. The temperature of water in the streams from which the hatchery supply is taken very often descends to thirty-four, and it is therefore quite obvious that the natural incubating period may be half that of the hatcheries. Some authorities are opposed to the use of spring water because

it hastens the incubating period and compels the liberation of fry in the late winter when food is at its minimum, but it is reasonable to presume that in springy localities the same temperature that hastens egg incubation also hastens all other forms of aquatic life and food is thus automatically provided.

In any event water of warmer winter temperature than that used in the hatcheries is the natural element, and the aversion to its use is based on the presumption that the temperature of the running water in a stream determines the length of the incubating period of the eggs that are deposited in it. This is not so, however, for temperature readings taken from beneath the bottom of streams, and from holes dug in the banks and bars, gave temperatures as much as eight degrees higher than that of the running water above, and I am also partially convinced that the time of emergence of the fry is not dictated by the absorption of the sac alone and may depend on the temperature of this blanket of cold water above them.

Another point in this connection I wish to emphasize is, the sequence of the time of spawning of the different kinds of Pacific salmon is: sockeye, humpback, spring, dog and cohoe. This sequence also obtains in a general way in the comparative strength of fry of these fish. Heretofore sockeye eggs, when procurable, were the only salmon eggs handled in British Columbia hatcheries, where their development was retarded in surface water of low winter temperature, while their aggressive and less worthy cousins, hatched naturally in spring water, had advanced in growth sufficiently to be able to devour the sockeye fry when they were liberated.

The moral is that in the absence of good reasons against it, the liberation of the fry of any species should synchronize with that of the same species in nature.

DEPOSITING THE EGGS NATURALLY.

In depositing the eggs the action of the fish's tail scoops a hollow in the gravel, and the eggs when expressed, are carried by the current into the interstices. The eggs are not deposited in masses, and as the fish works forward they are covered. This takes place while the eggs are in the soft state, and as they harden and swell they assume the shape of the interstice in which they

happen to lodge. When they have hardened all movement is presumed to have ceased and they remain immovable and in darkness till the fry hatch.

This is only theoretically so, however, for in nature especially the best laid plans often come to grief. Very likely before the eggs have hardened another pair of fish dig them up in the act of depositing their own, and overseeding, the principal destroying factor in natural propagation and the automatic governor of reproduction prior to the advent of the white man and intensive fishing, still has some effect in certain localities.

I know of humpback spawning beds that are sometimes spawned over ten times, and in many cases the eggs of finer and early running varieties, such as sockeye, are dug up by dogs and cohoes. Washouts in the streams and receding water, leaving the eggs dry, are also foes to natural spawning, and many eggs are devoured by trout, etc., before they are covered.

Judging from the necessity of egg picking in the hatcheries and the bad effects resulting from fungus if it is neglected, one would suppose that the loss due to fungus in the gravel would be enormous. From experiments and observations I am convinced that the loss from this cause is negligible because the eggs are not deposited in masses, and also because the infertile egg, the source of nearly all the trouble in hatcheries, if not disturbed and kept in darkness, has an existence that covers the incubating period. This life may be described as merely a state of existence without growth. Very little abuse will extinguish this existence, and sudden changes in temperature are also fatal, and it is considered good hatchery practise to abuse the eggs until they are eliminated.

I contend that the removal of the infertile egg, and in fact picking of any kind, is wholly unnecessary, and that the presence of dead eggs of any kind should be viewed as a sign that there is something wrong with a system that produces them.

I first noticed this phenomenon in 1916 amongst some dog salmon eggs I had buried in gravel, when I dug into it to see what was happening, and in 1917 it was quite evident in many whitefish jars. On December 5th, 1917, I filled a whitefish jar with infertile eggs and gravel and on the 5th of April, 1918, these infertile eggs had not decomposed and were in as fresh a state

as when buried four months before, while eggs spawned the same day and fertilized, had hatched. I put this lesson into practise at Cultus Lake Sub-Hatchery, which is under my charge, in 1916 and 1917. The troughs there are within two hundred feet of the fish traps and consequently it is an easy matter to place the eggs in the baskets before they harden. When this was done no picking was necessary, and the eggs were not disturbed until they were well eyed and then only because the accumulation of silt, etc., compelled shaking up, which, of course, ended the existence of the infertile eggs. I did the same thing with humpback eggs at Harrison Lake; put them in the baskets soft, never disturbed them till well eyed, and then separated them in brine.

DEPOSITING THE EGGS IN HATCHERIES.

In any instructions I ever read regarding the handling of eggs, no mention is made of the desirability of getting the eggs into the baskets before they harden. On the contrary the method usually advocated is to allow them to harden before they are put into the trays in which they are to be transported, and some hatcherymen even allow them to harden in the milt.

If the eggs are taken at a distance from the hatchery it is impossible to follow the method I advocate, and the best results need not be expected.

At Cultus Lake the spawning pans, holding five quarts, were filled, carried to the troughs and emptied into the baskets, where they were washed. Thus two operations sufficed instead of the customary five, namely, spawning pan, washing pan, measure, tray and basket, and in addition no first picking was necessary.

The transportation of eggs, especially those not eyed, is inimical to the production of strong fry, for though it may not actually kill, it has a weakening effect.

GRAVEL HATCHED FRY.

Assuming that the fry have hatched successfully in the gravel, in spite of the drawbacks enumerated, we find that the fry stay in the gravel until the sac is absorbed, and longer under certain conditions which at present are unknown.

It may depend on the food supply, on season, or on the temperature of the water, but I am convinced that the time of

emergence is not dictated entirely by the absorption of the sac. When I emptied the gravel out of some boxes last spring I found a few very large fry, fifty per cent longer and two hundred per cent heavier than any I had previously seen come from the gravel. I showed specimens of these fry along with others taken from the natural beds and from the troughs to Mr. Cunningham, Mr. Babcock, Mr. O'Malley and Dr. Gilbert and they were all astonished at the contrast.

I am convinced that the contents of the sac was not alone responsible for this fine growth and the only feasible explanation I can think of is that they fed on the dead eggs or on the other fry, and this hypothesis is not unreasonable when we know they will eat the bodies of their parents. I also contend that the large eye, so evident in these fry, is a certain indication of strength and a great aid in eluding their enemies. Fry that hatch head first are weaklings and they have all small heads and eyes. Fry hatched in water of high temperature, sixty degrees or thereabouts are what we call "pinheads," which means that their heads are not developed. Examine the screen at the foot of a trough in which the fry are hatching and you will find a preponderance of small eyed or blind fry amongst the abnormalities.

HATCHERY FRY.

Hatchery fry are born under a handicap due to indirect water circulation, handling, and the bad effects of light, and this follows till they are liberated. They are on the move continually and the contents of the sac is dissipated in energy, which is unnatural. This movement is due to an inclination to get to the head of the trough and fresh water, or to avoid the light, and, to prevent piling up and consequent suffocation, they have either to be riffled or the screens so placed to attract the fry under them.

Provision against light usually consists of a few covers on the troughs or blinds on the windows, and these are inadequate, and the movements of the attendants has such a taming effect that they will actually come to meet them if they are being fed.

As I stated before, the smooth sides and bottoms of the troughs are not conducive to fostering their hiding proclivities and this soon becomes weakened; to counteract this somewhat I placed a layer of fine gravel in the bottom of all the troughs last season, with good results.

HATCHING FRY IN GRAVEL IN CONTAINERS.

Having thus demonstrated to the best of my ability that the predominating features of natural reproduction are the production of strong fry and lack of protection, while the reverse obtains in the hatchery method, I now proceed to show how these defects may be overcome.

In a general way, what I advocate is to take the eggs in the customary way and place them in their soft state in a container where no movement can take place, where they are in complete darkness, and subject to a direct flow of water which is under control and not of a fluctuating surface nature.

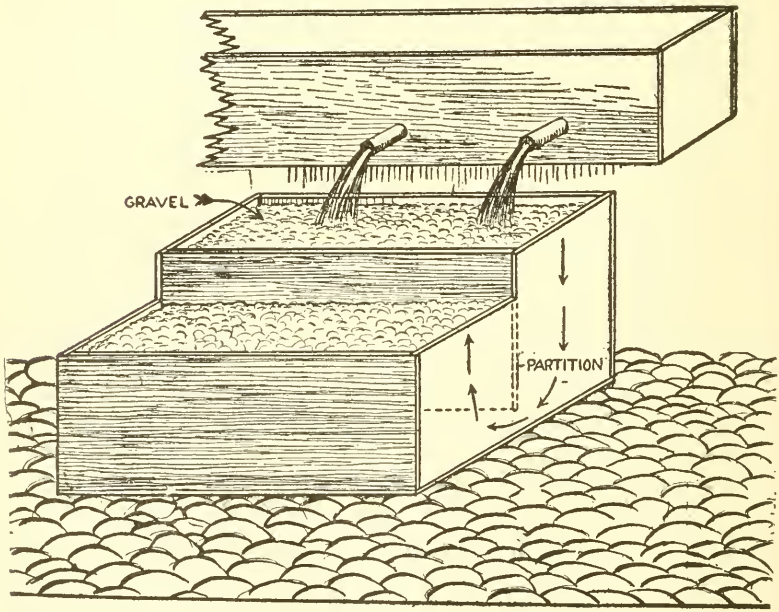
I have been compelled for lack of room in the hatchery to bury eggs in streams and beaches, but several years ago came to the conclusion that it was impracticable and not as good as the fish could do it themselves. Owing to their buoyant nature it is next to impossible to bury eggs under water, and when it was done it did not eliminate any of the faults of natural spawning with perhaps the exception of overseeding.

I then turned my attention to burying in whitefish jars, gasoline cans and boxes, and found after trying ten different forms of containers that the one I built first, a cut of which is appended, was the best of all. In the whitefish jar, where the water is conducted to the bottom through a tube and rises up through the mass of eggs, the principle of direct circulation is clearly illustrated, and all the other containers are merely modifications of this principle.

Gasoline cans, with a tube connected to a distributing board are practically the same thing. The water, however, may just as well be used going down as coming up and the wooden containers embody this feature. The use of whitefish jars is only recommended for experimental purposes as they allow a clear view of what is transpiring, but they are costly, easily broken and no better in operation than boxes made of common one inch lumber and lacquered.

If spring water is used danger from freezing is obviated and the boxes need not be in a building. They should be set up where the overflow spills into a creek or pond, which should purposely be left in its rough state to provide hiding places for the fry, or brush and rock added if cover is lacking.

In filling, the common run of gravel from two inches down is used, the larger rock serving to bear the superimposed weight, while the smaller holds the eggs in place. Much sand in the gravel is not desirable and large or small rock alone is not satisfactory; with one the interstices are too great, while the other works into the consistency of soup. Some of the larger sized gravel should be placed under the partition to provide free passage for the water, and two inches of the mixture on the remainder of the bottom. Some soft eggs, at the rate of one part of eggs to ten of gravel, are then gently and evenly distributed by hand and sprinkled with water to settle them into the crevices, and gravel and eggs added alternately until the box is full to within two inches of the top of the lower side. The remainder of the lower side should be filled with the mixture, and the upper side with fine gravel to within two inches of the top. This fine gravel acts as a filter and excludes debris.



Fry Hatching Container (A. Robertson).

The water at the rate of about one gallon per cubic foot per minute is then turned on, and thereafter no attention other than seeing the water is kept running is necessary. The eggs need not be actually in the water until the filling is completed, but this should be done as expeditiously as possible. To the uninitiated this may appear rough treatment for fragile fish eggs, but they may rest assured that no harm will ensue if the eggs are soft. To attempt it with hardened eggs is disastrous, but eyed eggs may be safely buried, and as an expedient this may be done with eggs eyed in the troughs and then transported and buried in suitable places.

In 1915 I had one container in operation. In 1916 seventy, and in 1917 ninety of ten different types, with a combined capacity of over two million eggs. Fifty of these are at Cultus Lake and were filled with sockeye eggs, all hatched successfully with the exception of two which were later found to have running pitch seams in the wood. This distressed the fry and they emerged with the sac on. The gravel in all these boxes with the exception of the two mentioned was found to be clean and free from dead eggs or fry when they were emptied.

In the course of my duties I visited this station in the day time once a week, and was struck by the fact that no fry were to be seen emerging. I mentioned this to the man in charge and he laughed and said: "If you were here after dark with a lantern you would find the top a squirming mass of fry." This peculiarity was later corroborated at Harrison Lake and indicates that fry planting should be done at night.

If the water in one of these boxes stops running, the fry will attempt to emerge, but if handicapped by too much sac they are unable to do so; on the other hand, if not distressed, they will descend as far into the gravel as they possibly can. I filled a jar half full of gravel and placed a quantity of eggs on top and when they hatched they all went down into the gravel.

I built a trough twelve inches square and twelve feet long, with single riffles two feet apart extending alternately two inches from the top and bottom, and filled it with gravel and eggs its entire length, afterwards nailing a cover on. When the fry ceased coming out I emptied the trough and in it found the large fry mentioned previously, all the others were gone, some of them

traversing ten feet of gravel. Many years ago I saw an instance where fry from a leaky pond travelled two hundred feet through the earth, emerging on a meadow; hence their ability to get out need not be questioned.

When I am asked if the gravel system is as compact as the other I usually suggest to the inquirer that he substitute "congested" for compact, for that is the way I view it. Last year I took out a group of four sixteen inch by sixteen feet troughs and in its place erected a system for sixty gasoline cans. I put one hundred and eighty quarts of humpback eggs in these cans in varying quantities and sizes of gravel for experimental purposes. Some of them were purposely overloaded and one hundred and twenty quarts would have been enough. Now one hundred and twenty quarts would have been a good load for the troughs I took out, but it must not be overlooked that the trough and basket method has only area, while the other has area multiplied by the depth of gravel: Anyway, compactness is no consideration when better results are obtained, and the same thing applies to the quantity of water used, which is twice that of the old way.

Another question I have been asked is, "Is the proportion of fry turned out as great as from the troughs?" Now, while I have never counted the number of fry emerging from a container, I have seen the contents of perhaps fifty whitefish jars hatch and the fry leave in plain view, and when I say that the proportion is as great or greater I know whereof I speak, and I also add that I consider that gravel hatched fry have ten times the chance of survival that trough fry have. One drawback is the difficulty of finding suitable water and the use of gravel is cumbersome and slow, but it is altogether likely that some other burying medium, which must allow for expansion and the passage of water, will be found to take its place.

Its principal recommendations are, low cost of installation and operation, but all the arguments for and against it pale into insignificance in the light of its chief recommendation, which is, **the production of strong wild fry.**

THE RACEWAY AS A FISH TRAP.

By A. Robertson,
Harrison Hot Springs, British Columbia.

In 1914, after the great disaster to the Fraser River sockeye salmon run of 1913, with the approval of Mr. Cunningham, Chief Inspector of Fisheries for British Columbia, I built a chute in Trout Creek with the object of ascertaining the power of salmon to ascend a stream devoid of natural resting places.

The circumstances of the catastrophe at Hell's Gate are familiar to all interested in the Pacific Coast fisheries, but, for the benefit of others, I would explain that it was caused by the dumping of great quantities of railroad building debris into a naturally restricted part of the Fraser River. Some time after the railroad was built, the situation was aggravated by the fall of a rocky cliff, the base of which had become weakened by the cutting of the road-bed. The north bank of the river at this point consists of a vertical and comparatively straight rocky wall, while the south bank where the trouble occurred was irregular.

The result of the dumping of so much rock was that these irregularities were filled up and a chute was formed in the river. Above and below Hell's Gate minor stoppages were caused in the same way, and these, for the purposes of this paper, are more important than the great blockade at the Gate as they show that very little interference with the course of a stream may result in great injury to the fish, and probably that considerable spawning areas are barred through minor obstructions.

For the benefit fo the lay reader it should also be explained that the ascent of salmon consists of a succession of diagonal rushes from side to side of the river or past obstructing projections. When the fish find themselves stalled in their ascent they instinctively cross the stream; they are incapable of sustained effort and must find resting places at short intervals.

The chute built in Trout Creek is one hundred feet long, nine feet wide and four feet deep, with an even grade of five per cent, and the velocity of the water, which varies according to height, is about ten feet per second. Many hundred attempts to ascend

this chute have been made by salmon, chiefly cohoe, but no fish ever succeeded in reaching the fifty foot mark, while ninety per cent failed under thirty-five feet. The behavior of the fish was the same in most cases; when they found themselves stalled they instinctively crossed to the opposite side trusting to find an eddy. The results of this experiment show that salmon are not nearly as capable as generally supposed, and incidentally the chute served another purpose of more immediate interest to hatcherymen. It proved that it could take the place of a fence or rack to stop fish for spawning purposes.

All hatcherymen who have attempted to keep a fence clean during a freshet in the fall when the leaves are falling will appreciate a contrivance that stops the fish, does not require cleaning, and with the added advantage that the higher the water rises the better it fishes. Of course it only serves to stop the fish, but if part of the water is diverted down the outside of the chute through a head-gate, or the chute built just above a small tributary it will be found that the fish after a few ineffectual attempts to rush the chute will compromise by taking the side channel.

The second season after building, a fence was constructed at the lower end of the chute and a pond formed in it by placing a two by twelve across the bottom. The fish leaped the plank, entered the fence through the lead provided, but could not get out of the upper end. Paradoxical though it may appear the chute formed a pen though open at one end.

Chutes could also be used to prevent the migration of inferior fish, and a little experimenting would determine the length necessary to stop these fish while allowing the others to pass. It would thus act as an automatic separator.

THE PARENT FISH AS A FOOD SUPPLY.

By A. Robertson,
Harrison Hot Springs, British Columbia.

In 1915 I buried seventeen hundred stripped sockeye salmon in the garden at Harrison Lake for fertilizer. In the spring I was astonished to find that many of these fish were intact and in

a fair state of preservation. I threw several into the ponds through which the fry are liberated and was surprised to see the fry attack them with such relish that in the course of a few days nothing but the skeleton was left.

Sockeyes in particular seemed very partial to them, and it was a fine sight to see several hundred fry tearing into one carcass, with as many more waiting down stream to catch the fragments.

It was the first and only food I had ever seen sockeye fry care for and thrive on, and on account of it they stayed much longer in the ponds than usual.

The following fall I buried a lot more fish in various ways to find out the best method of preservation, but either because they were fly-blown before burying or because frozen during the winter, none of them were in the same condition in the spring as those of the previous year.

However, two hundred dog salmon that I had thrown into the ponds in November came through the winter in good condition and met with the same fate as the sockeye of the year before.

Now, while the mode of preservation is still in doubt, the results are most decidedly not so. I have learned that the bodies of the fish must not be fly-blown before burying or frozen during the winter, and if kept in the water it must be running and under forty-five degrees temperature.

There is no doubt that they are a natural food for fry, for in the spawning streams the bodies of the parent fish lodge in log jams and amongst the rocks and stay there till spring. Then when the rising temperature of the water tends to decay, and freshets disintegrate the flesh, the particles are snapped up by the fry.

I am quite convinced that a little experimenting will lead to a sure way of taking advantage of this provision of nature; they have accidentally been kept over winter in two different ways and it can be done indefinitely. In connection with this I would cite the testimony of a very old Indian who declared that the hatchery fry were "no good because they had no mamma." He said that after the fish had spawned they died above the eggs and when the "papoose" came out in the spring they were assured of an immediate food supply.

WHITE PERCH NOTES AND METHOD OF PROPAGATION.

By Fred J. Foster,
U. S. Bureau of Fisheries, Neosha, Mo.

For many years large numbers of white perch (*Morone americana*) have been noted above and below the Dobsis Lake dam, in Washington County, Maine, during limited periods in the months of May and June. The following observations were made during the spring of 1918 in an experimental attempt to retain these fish for brood purposes and to collect eggs for propagation. Unlike the white perch of coastal waters, those of Dobsis and Compass Lakes remain throughout the year in fresh water and therefore the peculiarities of movements and conditions may or may not apply to fish of salt or brackish water.

The spawning season in this locality extends for at least two months, approximately the months of June and July, perhaps not more than 10% of the fish being ripe at the height of the season, with decreasing percentage toward the beginning and end. The first eggs were secured on May 27th. Operations were closed on June 20th, but on July 22nd the writer, with hook and line, took 22 white perch in Dobsis Lake, among which were 3 gravid females and a number of males still in spawning condition.

The first run of fish into the stream connecting Dobsis and Compass Lakes, during 1918, occurred on May 19th, and the run continued, in fluctuating numbers, throughout the period of observations. During the first three days, before the installation of the trap, an estimated number of 1500 perch had ascended the stream and settled below the dam. These remained about a week and then drifted down over the barrier net, which had sagged below the surface of the water in the swift current, and back into Compass Lake.

On June 3rd some 2800 fish were liberated between the barrier net and dam, for reasons which will be given later, permission having been received from parties controlling the dam to lower one of the gates sufficiently to prevent the barrier net from being submerged. On June 10th, one week later, it was considered advisable to change the location of this barrier net and during the

operation the fish, which as a rule lie in a deep pool some 50 yards above, suddenly took the notion of returning to Compass Lake, as had the former school.

A few days later a number of fish descended into the stream from Dobsis Lake, remained less than 24 hours and departed. A large school was noted along the shore of Dobsis Lake, some two miles from the dam. These remained in a limited area for some time, but were gone when we returned with nets.

The schools entering Dobsis Stream from both Dobsis and Compass Lakes, as well as fish secured from along the shores of the Lakes, showed all degrees of ripeness, from fish so green that it was impossible to determine the sex, to ripe fish. The foregoing would indicate that, unlike most fish of fresh water, the white perch has no preference as to spawning place or conditions; individuals in the school depositing their eggs wherever the school may happen to be. In fact, it was determined by opening a number of females at various times, that the eggs mature a few at a time over a period variously estimated at from 10 days to 3 weeks. Females would be stripped of a goodly quantity of fine ripe eggs and when opened would show at least one-third of the eggs which had not as yet separated from the ovaries. It is therefore reasonable to suppose, considering the movements of the schools, that a given individual may deposit its eggs at points miles distant.

Both web enclosures and wooden crates were used for retaining pounds and many experiments were made as to the number it would be possible to hold to a given space, and the proper flow of water through the pounds. All endeavors to empound these fish, however, resulted in failure. It was further found that the eggs secured from fish held for not more than 24 hours were of good quality; fish held from 24 to 48 hours produced eggs of only fair quality; from 48 to 72 hours, the eggs secured were practically worthless, and fish that were too green to ripen within that time failed to mature, the eggs hardened in the abdomen and the fish rapidly became blotched with fungus. Extreme care in handling and the most favorable empounding conditions failed to improve the results obtained. The males appeared slightly more hardy than females; after a few days, however, the milt would congeal and be valueless for fertilization. Just previous to the close of operations it was learned that experiments conducted by the

Massachusetts Department of Fish and Game, in holding white perch in both fresh and brackish water, produced approximately the same results. Holding in salt water is yet to be tried.

The possibility of securing better results by liberating the fish in the stream between the barrier net and dam, where with difficulty they could be seined up and sorted every third day, was the reason for releasing the 2800 fish previously mentioned. During the week prior to their escape no improvement was noted. This, however, was not a fair test of the feasibility of this scheme, as the fish were not in the best of condition when released. Considering the large percentage of green fish and the length of time it would be necessary to hold them, it is problematical if they would stand the necessary handling.

White perch eggs are very small, 50,000 being estimated to the fluid ounce, or 28 to the linear inch after being water-hardened. They are even more adhesive than the eggs of the pike perch and the use of starch to aid in separation seems of no value. Agate or marbleized spawning pans are considered best and a little milt taken first, assists in preventing the eggs from sticking to the pan.

It is well to sort all fish before starting to strip, as better results will be obtained if no delay takes place in manipulating the eggs after taking. The milt from a few males is first stripped into the pan, then eggs and milt taken alternately, the tail of each fish being used to stir the mass after the eggs or milt are taken. This serves the double purpose of thoroughly mixing the eggs and milt and assisting in keeping the eggs separate. After 10 or 12 ounces are taken, the pan is passed to an attendant who, with a feather, continues the mixing for a moment, then a small quantity of water is added and after stirring a minute or two longer the milt is washed off by repeated changes of water. After washing, the eggs are lowered into a pail of water. Water-hardening will take some 30 to 40 minutes and, despite constant stirring, some bunches will form and many eggs will stick to the pan or pail and feather. Good fertilization and care during water-hardening will greatly assist in preventing bunches of fungused eggs from forming while the eggs are in the jars.

The ribs of the white perch are so heavy and arched and the abdominal cavity so short that it is difficult to strip all the ripe

eggs from a female. Ripe eggs not secured will be naturally deposited in the pounds during the ensuing night. A number of females, weighing about a pound each, had every appearance of being spent but upon being opened were found to contain immature eggs and probably would not have spawned for at least a month. Their resemblance to spent fish was so marked as to deceive experienced fish culturists.

If the eggs cannot immediately be transferred to the hatchery after water-hardening, they should receive a change of water at least once an hour and the temperature kept as even as possible.

White perch eggs may be hatched in either open or closed top jars, the Downing jar being preferable. When the eggs are received from the field, they are passed through a bobbinet screen and from 12 to 15 ounces measured to each jar. The eggs do not circulate as satisfactorily as those of the shad or pike perch. The flow of water is adjusted to give as good a boiling motion as possible without flowing the eggs out of the jar.

The eggs are somewhat heavier after being held for a day in the jars and after eyeing will require a greater flow of water than when first measured up. It was formerly customary to replace open-top with closed-top jars after the first 12 hours, but an increased flow of water through the open top jar is equally as satisfactory.

It is impossible to separate the good and bad eggs while they are in the jar so that siphoning is impracticable. The eggs are extremely susceptible to fungus and, unless of exceptionally good quality, it is advisable to remove the fungused bunches, by screening through bobbinet, at least twice during incubation. The bunches from the first screening are thrown away, but from the second, which is usually done after the eggs are eyed, they are placed in "hospital" jars and will produce many fish. Should the eggs in these jars stick together in a mass and stop circulating, it will be necessary to close down the jar and stir the egg mass with a feather every half hour, until hatching is completed.

Eggs of good quality taken from fish held but a few hours in nets or pens, and properly fertilized and cared for in the field, will give little trouble and hatch fully 95%, while inferior eggs are a source of much annoyance and no amount of care during hatching will produce satisfactory results. There is practically no difference

in the appearance of eggs of good and poor quality, and only after working some time in the jars will the difference be apparent.

With a water temperature of 45 degrees, the eggs will show little development and remain nearly dormant. At a temperature of 58 degrees they will hatch in from 4 to 4½ days, while at 68 degrees hatching will take place in about 30 hours.

As the fry are so very small, nothing but good quality nainsook or silk is suitable for screening the collecting tanks. It is advisable to ship all fish from each tank at least every other day, if possible, so that all cast off shells may be removed and the tank and screen thoroughly cleaned to prevent overflowing.

From various experiments it has been determined that both green and eyed eggs may best be shipped in the ordinary 10 gallon transportation can. Four quarts of eggs may safely be placed in each can, and if the trip be one of but two or three hours, and the air temperature moderate, no messenger will be needed. For longer shipments, however, an attendant will be necessary to aerate the water and regulate the temperature.

It is not advisable to pour the water directly from the dipper into the can, as in aerating the water for fingerling fish. It should be transferred to a pail by means of a screened siphon, thoroughly aerated in the pail and gently returned to the can. The water in the can is then given sufficient motion, by means of the dipper or hand, to lift the eggs from the bottom and cause them to separate freely in the re-aerated water.

Placing ice in the can to reduce the temperature is also to be avoided. Cooling should be accomplished by placing a small quantity of ice in the pail while aerating or placing ice on the shoulder of the can or in the can cover, if the covers are adapted for holding ice. A sudden drop in water temperature, if more than 4 or 5 degrees, is injurious, and it is preferable to have a few degrees rise in temperature than to lower it during transportation.

Two lots of eggs were packed in smelt cases, under the same general plan as is used in packing trout and pike perch eggs, and appeared normal when removed from the case, after a period of 3 days, but after working for a day or two in the jars, both lots turned bad and not a single egg hatched. It is believed

that white perch eggs will not stand the drop in temperature necessary to this method of packing.

Efforts were also made to hold small lots of eggs for 24 hours, in a vacuum bottle, but the eggs were dead when removed from the bottle, presumably from lack of aeration.

Owing to their cannibalistic tendency it is well to distribute the fry shortly after hatching. A convenient and accurate method of securing the proper number to the can is to take down the jars just as they commence to hatch and measure the required number of ounces of eggs to the can. By gently stirring every half hour, equally good results will be obtained as if the eggs were permitted to hatch in the jars. By giving the water in the cans a swirling motion all shells and dead eggs will collect in a little bunch on the bottom of the can where they may readily be removed with a siphon.

The usual number carried to a 10 gallon can is 200,000. For trips of more than 10 hours' duration, however, 100,000 to the can will be found to carry better and give the messenger less trouble. The same methods of aeration and temperature regulation should be followed as that described in the transportation of eggs. With 100,000 to the can little if any aeration will be necessary and unless the hatching temperature is above 65, a 5 degree rise in temperature will be found advantageous.

A bright tin or white enamel dipper will show more clearly the almost transparent fry and assist the messenger to convince the applicant that the water in the can contains fish, otherwise, as told by a fish culturist of note, it will be necessary for him to "Plant water and have faith."

INDISCRIMINATE AND INCONSIDERATE PLANTING OF FISH.

By Dr. James Alexander Henshall,
Cincinnati, Ohio.

In the Transactions of The American Fisheries Society for June, 1918, I was much pleased to read a paper by Mr. Aldo Leopold entitled "Mixing Trout in Western Waters." This is a matter to which I gave much thought during my superintendency of the Bozeman, Montana, Station, and I am very glad that the subject has been broached.

Mr. Leopold is evidently a close observer of the streams and their inhabitants in the National Forest Reserve of Arizona, and has apparently given much consideration to the stocking of those streams intelligently. His conclusions are exactly in accordance with my own experience of twenty years in the U. S. Bureau of Fisheries. After observing the results of indiscriminate planting of several alien species of trout in certain streams in Arizona, Mr. Leopold says, in regard to the possible hybridization of the several species:

"1. Species of trout spawning at the same time may hybridize. More knowledge is needed on when and to what extent."

"2. These hybrids are less productive, and therefore less desirable, than pure stock. More knowledge is needed on how much their reproductive capacity is reduced."

The subject of hybridization and all speculation in that direction may well be dismissed, for it rarely, if ever, occurs in nature under ordinary conditions. In compliance with instructions, at the Bozeman station, I experimented with crossing the two closely allied species, rainbow and steelhead trouts, for several years. While the resultant progeny grew to be fishes of good size and fine appearance, they subsequently proved to be infertile.

In respect to stocking waters, Mr. Leopold says that the National Forest Reserve Service in Arizona will hereafter follow nature and stick to one species, and that empty waters will be stocked with the species that seems most suitable; also that stocked waters will not be further mixed, and that native species will always be preferred.

These conclusions are sane, sound and sensible, and agree with those of all practical fish culturists who have given the matter earnest thought and consideration.

As a general thing the streams of the eastern slope of Montana, Colorado and Nevada are comparatively pure and uncontaminated, except in the immediate vicinity of mining camps. There was always an abundance of fishes native to the streams, and their natural food was likewise abundant. Cut-throat trout, Rocky Mountain whitefish, and in certain streams, grayling, lived harmoniously, were well nourished and reproduced their kind year after year, a natural balance of species being maintained.

If these conditions had not been disturbed by the introduction of alien species, and depleted waters had been stocked with native fishes, this happy and natural condition of affairs might have continued for many years to come.

As a case in point I will instance a stream that was under my daily observation for many years. Bridger Creek, a fine mountain stream, flows within a hundred feet of the Bozeman hatchery. When I began operations there in 1896 the Creek was well stocked in about equal numbers with cut-throat trout, grayling and Rocky Mountain whitefish, and this relative condition had always existed. At the end of thirteen years, 1909, when I left the station for Tupelo, Mississippi, the waters of Bridger Creek contained neither grayling nor whitefish, and but very few cut-throat trout. This change was brought about through the accidental stocking of the creek with brook and rainbow trouts from the waste water of the hatchery and ponds. These aggressive species were in entire possession of the stream, the brook trout being in the majority, though neither species was as abundant as the natives were formerly. As the spawning season of the brook and rainbow trouts are at different times, spring and fall, this balance will probably be maintained through the depredations on the eggs, fry and fingerlings of each other.

At that time all the streams of eastern Montana were well stocked with native fishes, mostly cut-throat trout and whitefish, while the grayling existed with them in the tributaries of the Missouri River above the Great Falls. Subsequently indiscriminate stocking of these waters was made with alien species of

trout, for which there was no good reason or valid excuse, except that applicants asked for brook, rainbow or steelhead trout, and they were supplied. If the re-stocking had been done with the native fishes inhabiting each stream, its condition would be much better today. The cut-throat trout is a more desirable species for those waters than the brook trout, being gamer, growing larger, and is a better food fish. Fortunately these waters are too cold for the brown trout.

Even black bass, both species, were supplied to applicants for waters too cold for their existence, some within a few miles of Yellowstone National Park. I protested so strongly against this indiscriminate stocking that eventually all black bass applications were referred to me. The warmer water of lakes on the western slope of Montana are very suitable for the large-mouth black bass, and they have been stocked with great success.

When in charge of the black bass station at Tupelo, Mississippi, applicants were supplied with rock bass and yellow perch, both species being unsuited to the warm waters of southern Mississippi, and Alabama. In these cases such species as croppie, bream and bluegills should have been supplied. Many applicants hear of certain fishes, and without knowing anything about the proper conditions of environment for them, or their habits, but on the score, perhaps, of novelty, apply for them.

A lamentable instance of inconsiderate stocking with an alien species, and one with which we are too well acquainted, was the introduction of the German carp. At that time the unfortunate results of its introduction to our waters could not very well be seen or anticipated. It was intended, primarily, for the stock ponds of farms, as it was supposed that it would thrive in any kind of water, muddy or stagnant. It was supposed to be herbivorous and harmless to other species. In fact it was all supposition, and it was planted without much thought or consideration. But like everything German it proved to be a Goth, a Hun and a Vandal to all our native species, though commercially it is somewhat of a success. When President of the Ohio Fish Commission, in 1890–92, I had all the brood carp seined from the ponds and sent to market, and replaced them with bull-head catfish, a good fish for the table, and one that will thrive wherever a carp will. It

should be more generally propagated and introduced to ponds in the south and middle west. I trust that what I have said in relation to the methods of Federal and State Fish Commissions will not be construed as criticisms, for we are all prone to mistakes as the sparks fly upward, from Moses to the present day. I have merely stated facts that have come under my own observation during an angling experience of seventy years, and an experience of fifty years as a fish culturist and naturalist.

A NEW FORM OF FISHWAY.

By Professor Edward E. Prince, LL. D., D. Sc.
Dominion Commissioner of Fisheries, Ottawa, Canada.

The principle upon which fishways or fish-passes have been constructed in the past has been by arranging the gradient so as to enable fish to ascend from a lower level to a higher level, and thus surmount water-falls, dams, and other obstructions. The greater the height of the obstruction, the steeper, or the longer, the gradient requires to be, and the head of water, or the force and amount of water, permitted to pass through the fishway requires to be varied to suit the different kinds of migratory fish passing up.

EXISTING FISH-WAYS UNSUITABLE FOR ALL FISH.

Each species of fish has its own climbing peculiarities, as it were, and the fish-pass which would suit one kind of fish may not suit another, shad and gaspereaux or alewives being altogether different from salmon or sturgeon. There have been fishways in Canada which proved successful for salmon, but the force of the water killed the weaker fish, such as alewives or smelts. The force of the water knocked these feebler fish against the compartments, and dead fish were often found, proving the utter unsuitability of the fishway for the different kinds of fish attempting to ascend it. Such fishways, as the McDonald fish-pass, endeavored to get over this difficulty of momentum, or force of water, by devices which broke the force and reduced the momentum, but as a rule the introduction of complicated arrangements for this purpose resulted in the accumulation of rubbish, and caused other difficulties, so that the structure was often rendered useless.

My new fishway, which has been tested experimentally in Canada with every evidence of success, adopts the principle of the perpendicular elevator, and if the fish can be induced to enter it, there is no doubt that it will lift them to the top of the obstruction.

THE FISH ELEVATOR IN ACTION

(This plate published by the courtesy of POPULAR MECHANICS MAGAZINE.)

THIS FISH-WAY IS SIMPLE, PORTABLE, AUTOMATIC.

The invention may be described as a fish-trap into which the fish swim and are enclosed, and then lifted up, and dumped over fish swim and are enclosed and then lifted up, and dumped over the top of the obstruction. It works automatically by means of a counterpoise or tank which is filled with water by gravitation or by means of a pump, and when full it descends, and in doing so pulls up the fish-trap below containing the fish. Any fish that can be induced to enter a fish-trap can be enclosed and lifted up by this apparatus. It consists of a comparatively light frame work of wood, iron, or other material so as to be portable, and it can be taken to pieces and stored away during the winter. One of the greatest dangers to the ordinary fish-passes is the accumulation of ice in winter about water-falls, dams, etc., which may amount to many tons, and which, during the freezing and thawing periods in winter and spring, often breaks up the fish-pass and carries parts, or it may be the whole of it away. Moreover, freshets in spring damage and destroy many of the fish-passes now in use. In the new fish-elevator the frame work, as I have said, can be taken to pieces, and the structure is not in use during the winter, when no fish are ascending. It is erected just prior to the first runs of fish in spring, and remains in operation only until the last runs of fish in the fall. As a fine-meshed wire net-work covers the whole frame work, rubbish cannot get into it and fill it up. Moreover, its success does not depend upon the varying supply of water, as the filling of the counterpoise can be arranged by taps and valves so that it will operate at regular intervals, whatever the state of the river. There is no necessity for erecting this fish-elevator at the point where the main body of water falls over; but it can be placed to one side, or indeed in any position where the fish can find their way into it, and being raised automatically and dumped out on a level with the height of the obstruction, a sluiceway of greater or lesser length can be devised to convey into the stream above the falls, the fish when dumped out. It can be placed anywhere where fish can be trapped, and there is no necessity for placing it directly against the face of the obstruction for if dumped into a sluice-way the fish can easily swim, as stated, to the pool or stream above the obstruction.

FISH LED IN AND ENTRAPPED.

The entrance to the fish-compartment or fish-trap is wide, and as the whole structure is a light frame work, there is no shadow or darkness about it, and the fish are not deterred on that account. It has been found that many kinds of fish object to entering a dark hole or chamber, but in this case there is no more difficulty in inducing the fish to enter the fish-compartment than in entering any automatic fish-trap along the sea-shore or along the banks of rivers. In order to compel the fish to enter the fish-trap, a wall of wire netting or "a lead" is suspended across the river diagonally which prevents the fish from ascending as far as the foot of the falls or dam and forces them to lead or be guided along the wall of net and enter the fish-trap, as in the case of ordinary commercial fish-traps.

HEIGHT, OPERATION INTERVALS, ETC., CAN BE VARIED.

The height of this structure can be varied for every different condition, and as it works automatically by gravitation, or if necessary, by electric or other power, it will operate as successfully for a low dam, 10 feet high, as for an obstruction, 30 or 40 feet in height; in other words, it is independent of the height of the obstruction. By the arrangement of special valves the counterpoise can be filled at the top of the elevator, and emptied at the bottom of the elevator, at any desired interval of time. In some cases it is desirable that the fish should be lifted up at intervals of not less than two or three hours, in other cases, where great schools of fish are ascending, it should ascend and carry the fish up every 15 or 30 minutes. This can be easily arranged by adjusting the valves.

OTHER FISH EXCLUDED WHEN TRAP ASCENDS.

When the fish-trap has ascended, the vacant space, which it occupied at the bottom, would be a danger to the fish trying to enter during the interval. To shut off the entrance of fish when the fish-compartment is ascending or descending, a special door has been devised which drops down and keeps the fish out, so that they are compelled to wait until the emptied compartment completes its descent. Then, by a special device,

the outer door lifts up, and the fish can enter. There are indeed three doors to this elevator. One is at the back, which opens only when the compartment is at the top of the structure, and the fish find exit by it. The second door is at the front of the compartment, and opens only when the compartment is at the bottom of the elevator, and thus admits the fish, and a third door at the bottom of the elevator which drops down only when the compartment has ascended, and thus prevents fish from entering the space left vacant when the compartment is going up or down.

OBJECTIONS ANSWERED.

The only objections which have been raised to this device are objections which are not really of very great force. Reference may be made to one or two of them. Thus, it is claimed, that the fish-elevator affords no means for the descent of adult fish after spawning, or of the young fish. Young fish can overcome all difficulties, however, in descending streams, and they can be trusted to look after themselves; the main purpose is to enable the parent fish to ascend to the spawning grounds. It has also been objected that the fish might be damaged when being lifted out of the water, and carried up in the fish-trap or wire-compartment; but inasmuch as salmon and other fish damage themselves considerably in jumping precipitous falls, there can be little harm to the fish during the few seconds occupied in being carried up to the top of the elevator. It has been objected, also, that logs and floating debris, and especially an excessive flow of water, might damage the fishway, but as a rule it would not be placed in position until the logs and high water have disappeared, and to avoid danger, it could be safely placed at one side of the obstruction. It need not be placed against the dam or falls, but at 50 or 100 yards away, and longer or shorter horizontal sluices constructed to carry the fish from the top of the elevator to the water above.

ADVANTAGES SUMMARISED.

To summarise the advantages possessed by this elevator fish-pass, which has been protected by patent in the United States, it may be claimed that it is (1) suitable for every kind of fish which ascends rivers. (2) It is not affected by freshets or by

accumulations of ice, as it is dismantled during winter and operates only when the fish run in the spring, summer, and fall. (3) It is automatic and operated by a counterpoise supplied from an elevated tank which fills by gravitation or by hydraulic ram. It may also be operated by electrical or other power. (4) It is adapted to all heights, 10 feet to 100 feet or more. (5) It is capable of being placed in any position in front, or at the side, or some distance below, the obstruction. A longer or shorter horizontal sluiceway enables the fish to pass from the top of the elevator to the pools of water above the dam or falls. No mill or power house is deprived of any water-power. (6) By adjusting the valves, the ascending and descending movements of the fish-trap or fish cage can be arranged at any interval, 15 or 30 minutes, or many hours; thus allowing ample time for a sufficient number of fish to enter the cage. (7) Should more enter the cage than the counterpoise can raise there will be no movement until some of the fish swim out, but the counterpoise is sufficiently heavy to raise the quantity of fish likely to enter during the short intervals allowed. (8) The cost of this device is much smaller than most other fishways in existence. It can be built for a few hundred dollars, being little more than a frame work, lightly but strongly made; whereas, some of the best fishways are costly structures of cement, masonry and timber, and cost many thousands of dollars.

TERRITORIAL WATERS AND A SUGGESTED EXTENSION OF THE THREE MILE LIMIT.

By Prof. E. E. Prince, M. A., LL. D., D. Sc.
Dominion Commissioner of Fisheries, Ottawa, Canada.

On May 19, 1917, a German submarine seized the Norwegian steamer "Thorum" about four miles off the coast of Norway, and all who are interested in fisheries questions regarded this occurrence with special attention. It is generally thought that a three-mile limit is universally carried out, but in this case Norway protested that her territorial waters had been invaded, and international law violated, because she had always adhered to a limit of four miles. No doubt many people who regard themselves as well informed on the question of territorial rights on the sea coast, learned with surprise that Norway had, for over seventy years, enforced a limit greater than three miles, and in various national and municipal agreements had consistently carried this out. As long ago as June 18, 1745, Norway had enforced a four-mile limit.

MANY COUNTRIES CLAIM MORE THAN THREE MILES.

But Norway is not the only country that has enforced a more extended territorial limit of three miles, although her course is one of the few that has been recognized generally by other maritime nations. Spain, as long ago as December 17, 1774, also claimed six nautical miles along her coasts and the coasts of her colonies, and re-asserted this in several royal decrees, in 1775, 1785 and 1867. In 1869 it may be remembered that Spain re-asserted a claim to a six-mile limit around Cuba and her West Indian possessions. Spain's last decree, dated August 4, 1874, aroused, however, serious objections on the part of Great Britain and the United States. Italy has also enforced a limit of four or five miles; although in some special conventions with Austria, she adopted a three-mile limit, but it is doubtful how far this latter limit has been adopted. Indeed, when discussing this territorial question with the Western Powers in 1891, the Italian Government refused to recognize a three-mile limit, and certainly Genoa has never relinquished her claim to complete territorial rights extending over the waters

of the Ligurian Sea. It is interesting to note under the Treaty of Paris, 1763, it is specified that French fishermen shall have the liberty of fishing in the Gulf of St. Lawrence on condition that they do not come within a limit of nine geographical miles of the coast, nor nearer Cape Breton Island than 45 miles. The large claim of Great Britain to exclusive authority over the waters all around her shores, and extending in the North Sea to France and to Norway, was considerably interfered with by various Royal and Parliamentary Concessions. Indeed, up to 1851 the fishermen of Belgium had the right to fish within three miles of the British shores under a charter of Charles II, and the French fishermen also claimed privileges, which up to then, the Dutch fishermen had solely enjoyed. These concessions were of so uncertain a character that the British Government admitted until 1851 that the foreign fishermen referred to, might continue to fish within territorial limits if they proved to the satisfaction of the English Courts the validity of their claim. As M. Luis Maria Drago stated at The Hague Tribunal in 1910, in the coastal waters a century or two ago (when the doctrine of Selden's "Mare Clausum" was at its height), distances were fixed by various nations up to 60 miles, 100 miles, or a two days' journey from the shore, and the like. There was the utmost diversity and contradiction in the regulations which it was attempted to enforce in various seas. Indeed, the principle of "land kenning," i. e., claiming as much water as was covered by the distance land was visible from a ship at sea, had been adopted before the time of Grotius.

INTERNATIONAL THREE-MILE LIMIT INVALID.

It is an error, therefore, to claim, as has been very generally claimed, that a three-mile limit is an ancient accepted rule, universally recognized and admitted down to our own time. If it be asserted that such a limit is a canon of international law we are driven to ask, "What is international law?" about which so much has been said and written.

INTERNATIONAL LAW IS REALLY INTERNATIONAL MORALITY.

It is true that quite an extensive legal literature has grown up since the time of Grotius (1625), and other less known jurists, who gave definiteness to the general tendency of civilized nations

on this subject, chiefly in the famous "De jure belli et pacis." Yet even great jurists have felt that international law is a flimsy thing, and one of the greatest modern writers on the matter found himself compelled to speak of it as a branch of jurisprudence, which is the creation of moralists, merely moulded by the acumen of legal authorities and the wisdom of statesmen.

It was so well-known a writer as Professor Sheldon Amos who admitted that international law was very immature, ambiguous, and indefinite, and was lacking in legislative authority. The opinion of John Austin, an eminent authority on jurisprudence, is generally admitted to be sound, and he does not hesitate to say that "international laws are improperly so termed," the laws being framed and emphasised merely by the opinion of an indeterminate body of men. As the three-mile limit derives its authority from such indefinite moral and ethical principles and summaries of international sentiment and obligation, its foundation is vague and unstable. John Austin very properly designates it "positive international morality." Law, to have any force or meaning as Sir Henry Maine stated, implies not only an authority to pronounce it law and to define it, but a tribunal capable of enforcing it. There exists no international tribunal sufficiently powerful to bind sovereign States by its decrees, and use compulsion if they transgress those decrees.

During the great war some interesting questions arose as to the cargoes held in seized German steamers at the Antipodes, and the New Zealand Chamber of Commerce, in the capital city of Wellington, when discussing the question of charging certain costs against the seized ships found the objection raised that such could not be done under international law, because at the end of the war these seized steamers must be handed back to the German owners. The President, Mr. C. W. Jones, a prominent New Zealand merchant, thereupon declared to his colleagues that "there has been no such thing as international law since the great war began." International law, it was claimed, can be violated with impunity and amounts to little more than international etiquette or morality.

Important maritime powers in former days assumed authority over vast oceans and seas, and had even Papal sanction for these extensive territorial claims. The known oceans of the world were

largely divided amongst the leading states as their national property. Britain, when she became a great maritime power, and rival of Spain and the Netherlands, asserted very wide claims over the seas. The House of Commons, in 1660, declared that foreign vessels were prohibited from fishing within eight or ten miles of British coasts; but the prohibition was generally ignored. During the eighteenth century the principle of "armorum vis" became pre-eminent, owing to the great naval wars, and waters within cannon-shot of the shore became regarded as territorial. Bynkershoek's principle "terrae dominum finitur ubi finitur armorum vis" appealed to warring nations, so that a 3-mile limit became regarded as equivalent to armed power, or force of arms, i. e., equivalent to the range of guns, and the exclusive right of fishery within such limit became an implication; but it is doubtful if three miles ever was the real limit of artillery range and certainly the limit is obsolete in modern warfare; even for civil and national protective and other purposes. A three-mile limit has always been regarded as quite insufficient. When Venice was an independent power, she exercised absolute dominion over the whole of the Adriatic sea. Every ship entering that sea had to acknowledge her authority, consent to be examined, and pay the tribute enforced. The Pope, who possessed Ferrara, about 50 miles south of Venice, was annoyed that his ships were overhauled and their cargoes taxed by Venice, and he called the Venetian Ambassador to Rome to explain the position. That officer explained that Venice had absolute and perpetual dominion over the Adriatic sea by enactment of the "Donation of Constantine." The Adriatic Sea is about 500 miles long, and averages more than 100 miles in width. Although the excessive and obsolete claims over the "common ocean," to use M. Drago's words, have been largely relinquished, the assertion of exclusive property over large tracts of water, has not been abandoned by many of them. It is an interesting fact that the very first definition of the three-mile limit of coastal jurisdiction was contained in the Treaty of 1818, between the United States and Britain, but neither of the powers signing that Treaty has rigidly carried out a three-mile limit even on its own shores. The United States has always exercised the rights of exclusive property over Chesapeake Bay, Delaware Bay, and other areas, and Britain quite recently insisted upon her

rights in the Moray Firth, beyond the distance of three miles from shore.

THREE PREVALENT ERRORS REGARDING THREE-MILE LIMIT.

Prevailing ideas upon the question of territorial waters seem to me to urgently require revision, hence I venture to bring the subject before the American Fisheries Society for consideration. The members of this Society are interested in everything pertaining to the conservation of the fisheries, and if it can be shown that the so-called three-mile limit is insufficient and unsatisfactory from a fisheries' point of view, I venture to hope the Society may place itself on record as favoring a satisfactory readjustment of the matter, and that the leading maritime nations may adopt a limit better fitted to conserve the just rights and interests of all concerned.

Space will not permit reference to the "headlands question" and other points, and I shall keep the fisheries mainly in view.

There are three common errors in the minds of many so-called experts regarding the three-mile limit.

(1) It is regarded as very ancient and venerable, and as established by antiquity and usage and by the general consent of nations. (2) It is regarded as universally applied and adopted. (3) It is asserted to be a canon of international law.

None of these assertions are true.

Let me take the last first. If it be claimed that international law has laid down the principle that no territorial sovereignity exists, or can be claimed, beyond the three mile zone, we must ask, I repeat, "What is international law?" It is true that there are Conventions and Treaties and understandings between nations. These are the only definite materials which can be regarded as having any force or binding power. Apart from these, international law is a compound of vague affirmations and claims with little possibility of enforcement, and liable at any moment to be violated or to be ignored with impunity. A great modern authority said that international law is "jus inter gentes"—consisting of natural and conventional elements, and so far as it is a law of nature, it is of uncertain obligation, while even the positive elements in the shape of treaties, agreements, precedents, etc.,

are only obligatory in so far as the nations concerned regard them as having moral force. International law is indeed derived originally from general and abstract theory, and it is difficult to see how it can have the same force and obligation as the criminal and civil laws of nations.

Germany, when she ignored her solemn treaties and violated the requirements of international morality, showed how futile are the claims made on behalf of international law. It fails when most needed. It is merely a collection of requirements in which the opinions of an indeterminate body of men are crystallized, and these opinions may or may not govern the conduct of those independent political societies which we call nations. If the three-mile limit is an essential part of international law, it has neither weight nor imperative obligation to support it. A country like New Zealand, with no foreign neighbors near at hand, and not bound by treaties or formal agreements with sister countries, is free to establish any territorial limit which she is prepared to enforce. Indeed, in some recommendations which I made to the New Zealand Government five years ago, I recommended that owing to her isolated situation she could be justifiably the first to announce a 10-mile or 12-mile territorial limit for the benefit of her sea fisheries. The principle applies, of course, to all countries, except in so far as they are bound by treaties with particular nations, or groups of nations.

It is a mistake to claim that the three-mile limit is universally recognized or adopted. The main ground for this opinion is based on the fact that some of the most important nations in the world in their treaties and conventions with one another have, at times, specified three miles as a territorial coastal area. Such nations as the United States, Great Britain, and France, and some of the nations bordering on the North Sea, have done so, but because, in certain instances, two or more nations have bound themselves by such limitations, there is no reason why any country that desires to do so, and is free to do so, may not claim more than three miles as its territorial boundary waters. The examples already given of maritime people like the Norwegians, or the Swedes, who have asserted their authority over more than three miles suffice. That Norway has not hesitated in her claim, is proved by the fact that she recently promulgated a new law

specially prohibiting foreign trawlers from approaching within four miles of her coast. The violation of this law renders the offenders liable to a penalty of from one thousand to five thousand kroners, and the confiscation of the offending vessels. The British Government directly called the attention of trawlers from British ports to the existence of this law, and in the official notice from the Board of Trade, London, dated November, 1908, and signed by the Assistant Secretary, Mr. Walter J. Howell, and headed, "Notice to owners and skippers of trawlers in territorial waters," it is stated that "The Board of Trade desires to call attention to the fact that a new law has recently come into force in Norway under which fishing with a trawl is forbidden in Norwegian territorial waters. * * Territorial waters of Norway are four English miles, not three miles."

Attempts have been made at various times to induce Norway and Sweden to reduce this coastal limit, and when these two nations separated from each other the British foreign office urged Norway to join in the North Sea Convention of 1882, but she rejected the proposal, because it would have bound her to a three-mile limit. It is interesting to note that Denmark enforces a three-mile limit in her western waters, but a four-mile limit in the Baltic Sea.

It is by no means true, moreover, that the three-mile limit has the authority of antiquity or the universal consent of leading nations, and some of the most famous jurists, such as Martens, admitted that any nation might acquire marine dominion beyond a three mile limit; indeed he asserted that three leagues, not three miles, was really the limit. Nor is the idea correct that gun-range in old times was three miles, and that the limit was based on that. Indeed, the earliest authority to announce the theory was the Sicilian Secretary of the Italian legation at Paris, Galiani, who first stated that a distance of three miles was equivalent to the range of guns, yet that two leagues, or twice that distance, should be the area for observing neutrality, or in other words should be the limit for enforcing territorial rights. Moreover there was uncertainty as to the base from which the three miles might be measured. Norway and Denmark and some other countries adopted a straight line drawn from point to point along their coast, and measured the three miles from that. An ancient

authority establishes a much greater distance than three miles, and the limits were fixed at 60 miles, or 100 miles, or two days' journey from the shore, and so on, and it was not until the Treaty of 1818 that three marine miles assumed definiteness as a limit of coastal jurisdiction.

M. Luis M. Drago, in his important addendum to the Award of The Hague Tribunal on the North Atlantic Fisheries (Septemper 7th, 1910), says "The Treaty of 1818 is one of the few which mark an era in the diplomacy of the world. As a matter of fact it is the very first which commuted the rule of the cannon-shot into the three marine miles of coastal jurisdiction," and Kluber specially referred to the Treaties of October 20th, 1818, and August 2nd, 1839, as fixing a distance of three miles from low-water mark for coastal jurisdiction, but it must be added it fixes the limit only for the nations who are party to such conventions.

The unratified Treaty of 1888, between Great Britain and the United States, specified three marine miles seaward from low water mark. It is to be noted, however, that unless the nature of the mile is defined, great uncertainty arises when three miles are mentioned in a Convention or Treaty, because the length of a mile varies in different countries and has undergone great changes at different periods of time. Before the reign of Elizabeth, an English mile was 5,000 feet, but in the thirty-fifth year of her reign, it was defined as eight furlongs, or 1,760 yards of 3 feet each. The English nautical or marine mile is 2,025 yards; but the German geographical mile is equivalent to four nautical miles, i. e., one-fifteenth of a degree. The German short mile is 6,859 yards, the French mile 4,263 yards, the Dutch mile 8,240 yards, and the Spanish mile is 4,635 yards.

There is no uniformity in the terms used to define territorial limits, in various treaties. Thus in the North Sea Convention of 1882, between Great Britain, Denmark, France, Germany, Belgium and Holland, three geographical miles are specified, whereas a marine league, or three marine miles is the distance mentioned in the Treaty (unratified) of 1888, between the United States and Britain. Three marine miles are specified in an early Fisheries Act in Canada, viz., the New Brunswick Act, passed on April 30th, 1851, by the Legislative Council and Assembly of New Brunswick (Act 14, Victoria, Cap 31).

NO THREE-MILE LIMIT ON INTERNATIONAL BOUNDARY WATERS, GREAT LAKES, ETC.

The Great Lakes, though from a legal point of view regarded as "high seas," and so defined by the Supreme Court of the United States, are really wholly territorial, being Canadian on one side of the boundary line and American on the other, a breadth ranging from 5 to 200 miles. The fishermen of one country are prohibited from operating in the waters on the further side of this imaginary line and the fishermen of nations other than the two bordering on the lakes are absolutely excluded altogether. They are in every sense extensive territorial waters separating two great countries.

In the Gulf of Georgia and Juan de Fuca Straits, Canada and the United States, by the Award of October 21, 1872, each acquired territorial waters on either side of the boundary line ("the line of demarcation between the territories," the Treaty of 1846 expresses it), from one to twenty miles from shore, while by the Award of October 20, 1903, the United States acquired territorial waters on the Alaskan boundary extending from four or five to thirty miles north of the line* extending from Cape Muzon to Cape Chacon; and Canada on the south side of that line acquired territorial waters of forty miles in breadth.

LARGE TERRITORIAL LIMITS FOR SPECIAL FISHERIES.

There are numerous instances where a special industry has required limits far in excess of those generally recognized for ordinary fishing operations, and large limits have been adopted without hesitation. The Russians, for example, reserved for a long time the White Sea for sealing, and in 1911 established a 12-mile limit in that sea or rather in Barents Sea; and Great Britain and Norway, assented to that claim. The line is drawn from Cape Svtoai to Cape Kanin. Norway, in like manner, closed Vanagar Fjord, in order to preserve the supply of whales. Great Britain, Sweden, Norway, Russia, Germany and Holland passed concurrent legislation to preserve the Jan Mayen Sealing Industry east

* The Treaty defines the line as "the line of boundary between the territories."

of Greenland. The Behring Sea Tribunal in 1893, established a 60-mile zone for fur-seals. A similar zone of 10 miles in the north part of Behring Sea, and a 30-mile zone around Robbins Islands were determined by an agreement between the United States, Russia and Great Britain. Delaware Bay, which is 20 miles wide at the entrance and 30 miles across inside, and 70 miles long, is recognized as within the territorial jurisdiction of the United States, while Chesapeake Bay, which is 12 miles wide at the entrance expands into a large arm of the sea, 270 miles long, and it is entirely closed to all foreign fishermen. Thus, when the fishery interests of a nation require it, the so-called three-mile limit has been repeatedly set aside.

There has been a strong feeling in Canada that the waters inside Queen Charlotte Islands, on the Pacific coast, are really territorial, and so long ago as 1896 Canadian patrol vessels warned foreign fishermen against operating in those waters.Captain Walbran of the D. G. S. "Quadra" reported to the Department when this warning had been issued that his coming had been made known to many United States' vessels that had been fishing there, and he found only one operating, which left at once for Alaskan waters after being reminded of the warning, and, said the Captain, "not another vessel appeared in those waters for five weeks," during which he continued his patrol. The fishermen, in other words, recognized that they were fishing in Canadian waters, and the area is certainly almost entirely enclosed on three sides by Dominion territory. The waters at one point are 75 miles wide, but the mere width is not conclusive, as the entrance to Long Island Sound is 10 miles, and to Delaware Bay is nearly 30 miles wide. By the Alaska Treaty the northern end of Hecate Straits, or rather Dixon Entrance is territorial, and in Juan de Fuca Straits, in the south, the waters north of the boundary line are also territorial, and it is difficult to see how any waters between these two boundary lines can be claimed to be "high seas."

VALIDITY OF LARGER LIMITS THAN THREE MILES.

It may be said that the larger limits which have been referred to are special cases, which are exceptions to the general rule. This is not so. Quite recently on the Scottish coast a Norwegian steam fishing vessel, the "Niobe," was seized when trawling

in the Moray Firth.* Captain Mortensen, in command of her, was found guilty of operating in waters five miles from the shore, on the ground that the Firth had been set aside by the Scottish Fishery Board under the authority of the British Parliament as an area in which trawling was forbidden. The offender, when found guilty, protested that five miles from land was "high seas," but the Appeal Court, in London, dismissed this protest on the ground that the British Parliament had assumed jurisdiction over the waters in question, and it was not for a Law Court to decide whether it had gone beyond its authority, merely because a three-mile limit had been defined in the North Sea Convention in 1882, and Norway was a party to it. Doctor Bassett Moore, one of the most eminent and scholarly authorities on International Law, said that this final decision was in accordance with United States' policy, for the Courts follow the decision of those Departments of the Government to which the assertion of its interests is confined, i. e., legislative and executive.

It is an error, therefore, to claim, as has been very generally claimed, that a three-mile limit is universally recognized and admitted. A slight examination of the facts shows that it is by no means universally recognized. Uruguay, ten or twelve years ago, claimed jurisdiction five miles from shore, and only receded from her position when Great Britain strongly protested; but she still exercises domination over one-half of the river La Plata. The other half belongs to the Argentine Republic. The river is 135 miles wide at the mouth of the estuary, and as much as 50 miles wide over 100 miles from the open sea.

In 1876 the Chief Justice of England decided that a German captain had been illegally convicted of having caused the death of a number of British subjects in a collision with his steamer, the "Franconia," inside the three-mile limit. He stated that the conviction was based on International Law, not on a British Parliamentary Statute. It is very remarkable that no three-mile limit had been authorized by statute in Britain until forty years ago (1878) and in that year Parliament in London passed an Act

* The Moray Firth, 148 square miles in area, had been closed by the Scottish Fishery Board, but foreign trawlers persisted in fishing there, maintaining that the prohibition did not affect them, as a large portion of the Firth is outside territorial limits.

to remove the uncertainty. By this action of the British House of Commons, jurisdiction was declared to extend, according to International Law, to three miles from the coast line. The United States had taken like definite action long before. Indeed, it was no other than George Washington who enforced authority over waters extending to one marine league, or three geographical miles, from the coast of the United States, and he added that this did not fix the distance to which the United States might ultimately extend its authority.

In conclusion, it is only necessary to point out (1) the three-mile limit has not been universally adopted or recognized.* (2) Ancient writers and modern writers who have been regarded as authorities have specified more extended limits. (3) Britain and the United States, though they have both specified three miles as the limit in various Conventions and Treaties, have themselves claimed more, when occasion required, and have legally justified their claim. In Britain, until recently the three-mile limit had practically no legal force because it had no statutory authorization. (4) Important legal institutions and Congresses have favored a greater limit than three miles. It is necessary only to refer to the International Law Association which took action at its annual meeting in 1895, the International Fisheries Conference, Bergen, 1898, the French International Law Institution, and other important bodies, all of which have urged that a greater limit than three miles should be adopted, and in many cases a ten-mile limit was specified. (5) For the object of fishery conservation a larger limit is very necessary. The spawning grounds for fish, and nurseries for the young, require to be protected, and in a vast number of instances these are beyond the three-mile limits; while important industries such as the whale, mackerel, halibut, and other fisheries, have been threatened with total extinction, and require closed areas or sanctuaries against the intrusion of outsiders, so that when special reserves are established they can be effectively protected by the nation having jurisdiction, and a three-mile limit is usually not enough.

* M. Luis M. Drago (op. cit. p. 37) candidly admits that "there does not seem to be any general rule of international law, which may be considered final, even in what refers to the marginal belt of international waters."

The great salmon fisheries both on the Atlantic and Pacific coasts require a larger limit than three miles, if they are to be safeguarded in the future. We know that on the Pacific coast the King or Quinnat salmon do not wander far from the rivers in which they spawn, probably twenty-five miles distance is the limit, but the great schools of sockeye salmon no doubt go further out, and descend into deep water to their feeding grounds. To protect these fish when approaching the estuaries of the most famous salmon rivers, a larger limit than three miles is essential.

There has always been the danger that Oriental nations might find it worth their while to send their fishermen across to the Pacific shores of the United States and Canada, and by the use of purse-seines, and other destructive implements, within five or ten miles of shore, destroy great masses of fish before they reach the estuaries or inshore waters, just as the French, Portuguese, and other European nations found it worth while to cross the Atlantic and exploit the cod and other fishing banks on our eastern Atlantic shores. The danger on the western coast is not imaginary, for fishing vessels from Asia have already visited American inshore grounds close to territorial limits. One such vessel, the Japanese halibut schooner, "Sunburst," was wrecked in the summer of 1908, while fishing close to Victoria, B. C.

It is claimed that larger territorial limits would ward off many of the dangers, to which reference has been made, and would ensure that salmon and other fish within ten or twelve miles from the coast would be free from the risk of reckless destruction by foreign fishermen. In the interest of the fisheries of most countries, a wider territorial jurisdiction is urgent, and would ultimately be beneficial even to other nations more distant who would gain by the plentitude of fish that would ensue.

In recent years there have been numerous respesentations in favor of a larger territorial area, and in 1893 one of the most prominent Parliamentary advocates of British fisheries protection and preservation, the late Lord Tweedmouth, strongly advocated a limit of six miles as desirable for adoption by maritime nations generally. He had been chairman of various fishery commissions in Britain, and was looked upon as the mouthpiece of fishing interests in the British House of Commons, and his emphatic opinion after long years of experience was, that the present limits

of three miles were altogether inadequate. Following the lead of this eminent man, that important and powerful association in Britain called "The National Sea Fisheries Protective Association," meeting in Fishmongers Hall, London, on January 16th, 1894, passed a resolution which included the following:

"That in view of the difficulties of making international fishery regulations, they are of opinion that the best method for effectively governing fishing operations, and, at the same time, for securing, so far as it may be found possible, the proper protection of spawning and immature fish, would be to throw the responsibility of these duties, so far as the waters immediately adjacent to the various countries are concerned, on those various countries; that, for the effective realization of this object, the present territorial limit of three miles is insufficient, and that for fishery purposes alone this limit should be extended—provided such extension can be effected upon an international basis and with due regard to the rights and interests of all nations." It may also be noted that Inspector W. E. Archer, one of the leading fishery authorities in Britain, laid great stress in some evidence he gave before the Sea Fisheries Commission in 1907, that the three-mile limit for fishery purposes was practically insignificant.

Of special moment is the fact that at the commencement of the great war, in 1914, twenty-one American Republics, including Argentina, Chile, Brazil, Peru, Uruguay, etc., were moved to urge co-operation with the United States Government to extend the territorial marine limits, mainly to increase coast-wise trade between North and South America, but indirectly for the benefit of the sea-fishing industries also. Quite a large and representative body of men from these various republics arranged to confer with President Wilson upon this momentous subject.

It has been widely felt that six miles was not a large enough limit, and the fishermen of Scotland twenty-five years ago urged upon the British Government that the territorial limits should be extended and the line fishermen, who formed the majority, specified a thirteen-mile limit as necessary, and demanded that within this limit no trawling should be permitted. The Government officials in London replied that the consent of foreign nations concerned would be required; but as we have seen this opinion was entirely baseless, as proved by the decision of the High Court

of Appeal of England in the "Mortensen case." The well known Canadian Herring Commission, 1889, which published a splendid report upon all phases of the industry, refer on p. 79, to the prohibition of trawling in the three-mile limit, and they say: "We consider trawling, especially within the territorial limits, to be exceedingly injurious to the herring fishery. It is established on undoubted authority in Britain and Ireland that trawling scares away the herring from the fishing grounds, drives them away from the spawning grounds, and disturbs and destroys the spawn when deposited. The salmon, halibut, lobster, and flatfish fisheries generally, have been seriously injured, and in many cases destroyed, by the operations of the trawlers. We, therefore, consider that trawling and the use of all destructive seines and traps, calculated to disturb the herring in any way and to destroy large quantities of immature fish and spawn should be prohibited within the three-mile limit, and that efforts should be made by the Government to effect an international arrangement whereby the trawling on the high seas should be regulated and restrained when the herring schools are in close to the coasts so as not to drive them away from the fishing or spawning grounds, or disturb or destroy the spawn when deposited on banks outside the territorial waters." From a strictly scientific point of view the grounds stated by this Commission, for the action suggested, are not altogether well-founded, but it must be admitted that there is great force in the view that excessive fishing operations within short distances of the shore must injure all fisheries.

The extension of the territorial limits would enable better supervision to be carried out, at greater distances from shore, and in 1915, the Canadian Government authorized by Order in Council a prohibition of trawling operations within a distance as great as twelve miles. Owing to war conditions, enforcement was postponed. There is no reason, however, why such a special method of fishing as trawling only should be curtailed or controlled within that distance, but that all methods of fishing should be under wise regulation within a distance much greater than the present territorial limits off the shores referred to.

Lastly, in order that some practical results may be possible, I have, as urged by some leading members of the American Fish-

eries Society, framed the following resolution,* which I would submit to the Society and ask for their valuable support. This draft resolution reads as follows:

PROPOSED RESOLUTION.

"The American Fisheries Society places itself on record as being in full agreement with L'Institut de Droit International, Paris, 1894; the International Law Association, London, 1895; The International Fisheries Conference, Bergen, 1898; and other important representative bodies, which have urged the extension of the territorial limit in coastal waters, and have emphasized the fact that the three-mile limit popularly regarded as internationally valid is entirely inadequate, and that in the interest of fishery conservation and protection, and in furtherance of international amity, approves of a suggested larger territorial limit extending beyond the usually accepted three-mile limit on the coasts of the various maritime countries of the world."

* By vote of the Society, Dr. Prince was requested to frame this resolution to be printed in connection with his paper, in order that it may have proper consideration before the 1919 meeting. Members of the Society will please take notice that this resolution will come up for action at the comming meeting at Louisville, Ky., Oct. 8 to 10, 1919.—EDITOR.

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A PRELIMINARY REPORT ON A FISH CULTURAL POLICY FOR THE PALISADES INTERSTATE PARK.*

By Chas. C. Adams, T. L. Hankinson, and
W. C. Kendall.

1. Introductory Note.

The Palisades Interstate Park is located on the west shore of the Hudson River, and extends northward, as a narrow strip along the famous Palisades to south of West Point, where it broadens out in the Bear Mountain and Harriman Park sections, and extends westward about fourteen miles to the Ramapo River near Tuxedo. There are about 35,000 acres in the Park. It is under the supervision of Commissioners, of whom Mr. George W. Perkins is the President, appointed by the States of New York and New Jersey. For two seasons the Department of Forest Zoology of The New York State College of Forestry, at Syracuse, has been conducting an ecological survey of the Park. This work has been in direct charge of Mr. Edward F. Brown, Manager of the Camp Department in behalf of the Park, and of the senior author of this paper in behalf of the College. The United States Bureau of Fisheries has co-operated in this survey during the past season. The present paper is the result of a study of one phase of this survey, other lines of work under way being investigations of the birds, water bloom, mosquito control by fishes (in co-operation with the Bureau of Fisheries) and leech control.

This is a wild forest park largely in the mountainous Hudson Highlands, with many lakes and ponds and a few fine streams. It is the largest camping park in the world, with facilities for 70,000 campers. Last season (1918) with smaller equipment, there were about 50,000 campers who averaged ten days in the Park. The fish cultural problems of such a Park are thus not those of the usual sort.

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* Investigations conducted by the Department of Forest Zoology, of The New York State College of Forestry, at Syracuse, in co-operation with the Commissioners of the Palisades Interstate Park, and with the assistance of the United States Bureau of Fisheries.

The present paper is a summary of a fish survey made of the Bear Mountain and Harriman Park sections of the Park, mainly from the standpoint of stocking the waters with food and game fish. Mainly practical problems of immediate importance are here considered. The educational-recreational aspects are being given secondary consideration at this time, but are not ignored. Both popular and technical reports are in preparation on the Park fishes.

The field examinations were made by our party during August, 1918, and from June to the middle of July, 1919. At present we are reporting on six ponds or lakes, and on two stream systems. The waters so far examined are mainly those along the Seven Lakes Drive. Other important waters have not been examined at all, because of the lack of time at our disposal.

These waters present a number of unusual features which complicate the problem of fish culture more than is usually the case. The uses to which the waters of the Park are devoted are relatively more diverse than those of the usual wild waters. Furthermore the newness of the waters, having been formed or enlarged by dams, and their frequent changes of level, introduces uncertain factors which are not usually met with in fish cultural operations, and only time and further study can resolve this influence. The growth of aquatic plants has been changed fundamentally by these changes of level, and in the future as water plants become established on the new shores, the conditions for feeding and breeding of the fish, and fish food as well, will be materially changed, and the chances are that the mosquito problem will become more serious, because such vegetation offers retreats for mosquito larvæ away from the fish, as Dr. J. Percy Moore's studies in the Park have shown. At present the control of the mosquito problem by fish is relatively efficient in most of these waters.

The plan upon which the present recommendations have been based has been to learn for a particular water of the general intention of the Park officials and then to harmonize our formulations of policy and recommendations with this plan. As the purposes of the Park officials change, these plans must be modified.

As a result of our survey certain outstanding facts are evident and are of primary importance. These may be summarized as follows:

1. The waters of the Park are well suited for the cultivation of valuable food and game fish, such as: the Large- and Small-mouth Blackbass, Chain Pickerel, Rock Bass, Mud Channel Cat, Hornpout (Bullhead), Common Sunfish, and Perch.

2. With a reasonable effort the capacity of the waters may be greatly improved, both in the quality and in the quantity of fish.

3. The wholly new lakes furnish a favorable condition for starting right in stocking the waters.

4. The large pond and lake area is a distinctly favorable feature for fish culture.

5. Stream conditions are at a great disadvantage, and have been sacrificed for standing waters. It is now desirable to add streams to the Park area.

6. The police system of the Park is a distinctly favorable condition for fish production and use.

7. When a fish policy is once accepted for a given water this policy should be *followed strictly* until another policy has been definitely formulated and accepted. Errors in stocking waters and the miscellaneous planting of fish are often very difficult to remedy, often involving years of work to correct. Miscellaneous planting should not be permitted in the Park.

8. The planting of new waters should be made to harmonize with the general system of the Park.

9. An educational campaign should be a regular feature at all camps on lakes and ponds, in order to make the campers appreciative and intelligent about the use of the fish resources.

10. A few well-planned tramping trails along streams, particularly brooks, can be made a very valuable and attractive feature of the Park, and such waters should be well stocked with fish. The clear water, the fish and the beauty of those brooks, are at present but little appreciated parts of the Park today to most campers. City children deserve to know these streams.

11. Considering the importance of food and game fish in the Park waters, and at the same time the growth of water bloom which interferes with bathing, it is evident that these two interests

must be adjusted to one another. The copper sulphate treatment of the waters not only kills, to some degree, the food supply of young fish, but some fish as well. At present we do not have sufficient data to make this treatment wholly satisfactory, and a technical investigation of the problem is urgently needed, before intelligent practice can advance safely.

2. Report on Lakes and Ponds.

Hessian Pond (Highland Lake).

1. Physical Conditions and Vegetation. This is a deep lake, a large area covering from 25–35 feet in depth. The deepest sounding found was about 40 feet. The lake is clear and spring fed. The west shore is rocky and steep, and the other shores have a narrow shelf, largely sandy and gravelly. Near the north end is a small island with a shallow bayou on the north. There are but few water plants, most of which were at the south end and in the shallow bayou at the north.

2. Kinds and Abundance of Fishes. Golden Shiner, *Notemigonus crysoleucas* (Mitchill), abundant; Eastern Pickerel, *Esox americanus* Gmelin, one taken; Chain Pickerel, *Esox tridecemlineatus* Mitchill, probably abundant; Rock Bass, *Ambloplites rupestris* Rafinesque, one seen; Long-eared Sunfish, *Lepomis auritus* (Linnæus), abundant; Common Sunfish, *Eupomotis gibbosus* (Linnæus), not abundant; Large-mouth Blackbass, *Micropterus salmoides* (Lacepede), few taken; Small-mouth Blackbass, *Micropterus dolomieu* (Lacepede), reported abundant; and Perch, *Perca flavescens* (Mitchill); few taken.

3. Conditions for Fish. As a whole the natural food supply is not abundant. Artificial food, from lunches, is very abundant during July and August. The breeding conditions for the kinds of fish present are favorable. Very few natural fish enemies. Anglers numerous.

4. Policy for the Water. This lake on account of its proximity to Bear Mountain Inn and its large number of boaters makes its fish cultural use wholly secondary. It is believed that the fishing in this lake should be devoted mainly to the smaller fishes and Perch, which should be encouraged to full capacity.

5. Recommendations. In harmony with the preceding suggested policy it is recommended that: (*a*) Young Common Sunfishes and Perch can be spared from Cedar Pond and should be added here. A large number is desirable because of the intensive fishing in Hessian Pond. (*b*) Chain Pickerel and Small-mouth Blackbass should be encouraged in these waters by planting. (*c*) That Golden Shiners be planted. A supply of the young fish can easily be secured from Cedar Pond. These are needed as food for the predaceous fish.

Lake Number Five.

1. Physical Conditions and Vegetation. A shallow lake, formed by damming Queensboro Brook. Deepest water found was about twenty feet. The upper end of the lake is very shallow, abounding in water plants, *Sparganium*, *Potamogeton* and large patches of *Nymphœa*. July temperature, at depth of twenty feet, 53° Fahrenheit. A formerly cultivated farm, now flooded.

2. Kinds and Abundance of Fish. Fallfish, *Semotilus corporalis* (Mitchill), abundant about mouth of stream; Golden Shiner, abundant; Bridled Minnow, *Notropis bifrenatus* (Cope), abundant; Common Shiner, *Notropis cornutus* (Mitchill), not abundant; Common Sucker, *Catostomus commersonii* (Lacepede), probably abundant; Hornpout, *Ameiurus nebulosus* (LeSueur), one taken; Eastern Pickerel, abundant; Long-eared Sunfish, abundant.

3. Conditions for Fish. A shallow warm water pond, with an abundance of water plants in the upper end. Shallow water breeding conditions favorable for fish. Stream inlet available for stream breeding kinds of fish.

4. Policy for the Water. As a part of the Queensboro Brook system, these waters should be stocked with trout, as this is one of the best brook water systems within the Park area. It deserves to be carefully preserved as an example of that kind of a beautiful and valuable natural resource.

5. Recommendations. (*a*) That the Lewis and Queensboro Brook drainage system be reserved as a trout system. (*b*) That Lake No. 5 be stocked and managed to harmonize with this plan.

(*c*) That Brook Trout be planted in the brook, and thus the lake will be stocked. (*d*) That the Eastern Pickerel be discouraged in this system.

Nawahunta Lake (*Lemmons Lake*).

1. Physical Conditions and Vegetation. A very shallow pond, from 7 to 10 feet deep, formed by damming Lewis Brook. Temperature in July 68° Fahrenheit at 10 feet. A flooded and formerly cultivated farm. Few water plants present.

2. Kinds and Abundance of Fish. Hornpout, very abundant; Common Sucker, abundant; Eastern Pickerel, one young fish taken.

3. Conditions for Fish. A warm, very shallow lake with little aquatic vegetation. Inlet stream suitable for trout. More aquatic vegetation desirable. A water particularly suitable for Hornpout and sunfishes.

4. Policy for the Water. The inlet stream, Lewis Brook, is tributary to Queensboro Brook, and the entire system is advised for trout.

5. Recommendations. (*a*) Planting Calico Bass, *Pomoxis sparoides* Lacepede.

Cedar Lake.

1. Physical Conditions and Vegetation. This is a lake formed by damming a valley and uniting two ponds. The shore is largely rocky and with numerous small bays or coves at the southwestern end. No inlets; spring fed. The floating islands were formed by the bog floated by flooding, at both northern and southern parts of the lake. A single large and a few small rocky islands. The coves abound in stagnant water caused by the rich forest humic soil. A very large area of the lake is between 20–30 feet deep, with a small area, reported by Mr. W. A. Welch to be of about three acres in extent and about 40 feet deep. A large marginal belt is of about 16 feet in depth. The shores are steep with little sand or gravel, on account of their newness. Aside from the floating bog islands, at the north and south ends of the lake, and in most of the protected coves there are few water plants. Most of these are in the coves on the southwestern shore. There is a periodical growth of water bloom.

2. Kinds and Abundance of Fish. Eel, *Anguilla rostrata* (LeSueur), reported; Golden Shiner, very abundant, the most abundant fish in the lake; Black-nose Dace, *Rhinichthys atronasus* (Mitchill); a few taken at one place; Common Sucker, one taken; Chub Sucker, *Erimyzon sucetta oblongus* (Lacepede), not abundant; Mud Channel Catfish, *Ameiurus catus* (Linnæus), abundant; Hornpout, abundant; Chain Pickerel, abundant; Blue-spotted Sunfish, *Enneacanthus gloriosus* (Holbrook), abundant, in coves; Common Sunfish very abundant, in excess; Pike Perch, *Stizostedion vitreum* (Mitchill), reported; Perch, *Perca flavescens* (Mitchill), very abundant.

3. Conditions for Fish. A large, deep lake with clear spring water. Water of coves stagnant. Main food-producing areas about the floating islands, in the better parts of the coves, and in the marginal shallow water. Favorable breeding conditions for all the abundant species. The coves are favorable especially for the Golden Shiner and the Blue-spotted Sunfish. The natural enemies of fish are not numerous. Conditions appear favorable for the Small-mouth Blackbass. Fish planting sites easily accessible from the automobile roads.

4. Policy for the Water. This lake has been a favorite fishing ground for fishermen who come by means of teams and automobiles. *This is possibly capable of being the main fishing lake for adults in the Park.* It should be devoted to such fish as: Mud Channel Catfish, Hornpout, Chain Pickerel, Common Sunfish, Perch and Small-mouth Blackbass.

5. Recommendations. (*a*) Planting a large number of Small-mouth Blackbass. (*b*) Planting Chain Pickerel. (*c*) Reduce the number of Common Sunfish, by encouraging angling for the smaller lake fish, and netting the fish for planting other waters, as suggested elsewhere.

Kanahwauke Chain of Lakes.

1. Physical Conditions and Vegetation. This chain of lakes was formed by damming Stillwater Creek and raising the water level in the valley until the water backed up and joined Little Long Pond. The water is deepest in the lower lakes, and in Little Long Pond a depth of 43 feet has been sounded. All

these basins have a large area of shallow water. On account of the newness of two of the basins and the rising shore line, water plants are not well established at present, except on Little Long Pond there is considerable swamp margin at the west, and along the northeastern end. The most stagnant water is in the western end. There are no large inlets in this chain of lakes. The bottom temperature in July at 40 feet was 52° Fahrenheit.

2. Kinds and Abundance of Fish. Eel, one taken; Golden Shiner, abundant; Common Sucker, scarce; Chub Sucker, abundant; Hornpout, very abundant; Chain Pickerel, abundant; Mud Minnow, *Umbra pygmœa* (DeKay), probably abundant; Freshwater Killy, *Fundulus diaphanus* (LeSueur), a few taken; Rock Bass, apparently scarce; Common Sunfish, very abundant; Large-mouth Blackbass, abundant; Perch, very abundant.

3. Conditions for Fish. The conditions are favorable for an abundance of fish food, and for breeding. The predaceous enemies of fish are not abundant. These include Water Snake, Snapping Turtle, Kingfisher and Green Heron. Many Common Sunfish eggs were found moulded, even when protected by the parents. Considerable angling is done in these waters. These waters are easily accessible by automobile for fish planting. Large-mouth Blackbass breed in great numbers.

4. Policy for the Water. This series of lakes is devoted to the Boy Scout camps, where much attention is given to bathing and boating. The large number of boys here means that much fishing will be done. Large-mouth Blackbass and Chain Pickerel should be made the chief predaceous fish. The waters can not be seined easily on account of the brush and stumps. Fishing rules and plans for cooking should be formulated, similar to those later suggested for Car Pond.

5. Recommendations. (*a*) Leave these lakes alone and allow them to become stabilized under present conditions, as they are already well stocked with valuable kinds of fish. (*b*) Develop some fishing and cooking rules for this water, in order to conserve the fish supply, and to teach the boys proper use of such food.

Lake Stahahe or Car Pond.

1. Physical Conditions and Vegetation. The water is not clear and is somewhat stale. This was originally a bog pond, greatly enlarged. The floating bog has been largely removed. The shores are chiefly rocky, the bottom muddy, and with only a moderate amount of water plants. Subject to considerable growth of water bloom. The July temperature at 21 feet was 60° Fahrenheit.

2. Kinds and Abundance of Fish. Fallfish, found at mouth of small inlet; Golden Shiner, abundant; Bridled Minnow, not abundant; Common Shiner, at mouth of inlet; Chub Sucker, abundant; Hornpout, abundant; Tadpole Cat, *Schilbeodes gyrinus* (Mitchill), abundant; Chain Pickerel, not abundant; Mud Minnow, probably abundant; Freshwater Killy, not abundant; Blue-spotted Sunfish, abundant; Common Sunfish, abundant; Perch, abundant.

3. Conditions for Fish. That it was originally stocked with fish food is important. The increased depth has doubtless had much influence. The breeding conditions are apparently favorable for the most valuable kinds of fish found present. Planting sites are easily accessible from the automobile road. Liable to overfishing, and to influence of copper sulphate treatment for water bloom. Leeches unusually abundant, and they prey upon the fish. Other predaceous animals not excessive in number. Considerable mortality of fish observed, but the cause is not known. Frogs very abundant, a good food for Pickerel.

4. Policy for the Water. This is primarily a camping lake for women and children, where much attention is given to bathing. The waters are subject to a growth of water bloom, and the copper sulphate treatment must be reckoned with. Fish suited to line fishing, such as the Hornpout, Common Sunfish, Perch and Chain Pickerel, are all worthy of encouragement, because good fishing of these larger kinds may be made to add much to the pleasures of campers, and as well are of educational value to children. The Blue-spotted Sunfish is particularly adapted to aquaria, and to mosquito destruction. The furnishing of aquaria to each camp is worthy of consideration.

There should be some simple rules for children's fishing, so as to avoid unnecessary destruction of fish, and some provision made for cooking those caught. On conference with camp leaders we can prepare such fishing rules, which should be posted at each camp and on the shores.

5. Recommendations. In harmony with the preceding discussion of policy we suggest the following: (*a*) The kinds of fish encouraged should harmonize with a bathing lake, and the copper sulphate treatment. (*b*) Introduce no new kinds of fish until the present fish found become adjusted to the increased depth. (*c*) Plant Chain Pickerel to encourage a predaceous fish, and to provide a large fish to create enthusiasm for anglers.

3. Report on Trout Streams.

Lewis Brook and Queensboro Brook.

1. Physical Conditions. These streams are a part of Popolopen Creek drainage. The establishment of lakes along these streams are destroying them as trout streams by restricting their area, hastening evaporation and by warming the waters. The clearings along these streams also hasten evaporation, increase temperature, and decrease the food supply. The water supply is unfortunately limited. The establishment of a new dam at Queensboro will destroy a large area of favorable trout stream.

2. Kinds and Abundance of Fishes. Rainbow Trout, *Salmo irideus* Gibbons, a few young taken; Fallfish, abundant; Horned Dace, *Semotilus atromaculatus* (Mitchill), not abundant; Golden Shiners, abundant in quiet pools; Bridled Minnow, abundant near ponds; Common Shiner, abundant; Long-nose Dace, *Rhinichthys cataractæ* (Valenciennes), few taken; Black-nose Dace, very abundant; Cut-lip Minnow, *Exoglossum maxillingua* (LeSueur); Common Sucker, very abundant; Eastern Pickerel, abundant near ponds; Chain Pickerel, a few taken; Long-eared Sunfish, few taken near ponds.

3. Conditions for Fish. Water supply limited in volume and area, waters relatively warm on account of clearing and damming the stream. The food supply is not abundant. Streams probably

over-fished. Natural enemies relatively few, with possible exception of the Water Snake. Planting sites easily accessible to automobile roads. Favorable breeding conditions for the Fallfish.

4. Policy for the Water. On account of the paucity of favorable trout streams in the Park, it is advised that this stream be made as favorable as possible for trout. This stream can also be made a source of bait minnows for Cedar Pond.

This stream and Cedar Pond Brook are two of the most accessible and beautiful trout streams in the Park, and should be preserved so that *city children will have a chance to know a fine brook*. This is a natural resource of such value. A couple of attractive brook trails should be developed along these streams, and the presence of trout would lend much to their interest.

5. Recommendations. Brooks are an important natural resource in the Park. There are only a few of these, and several have been destroyed in pond and lake constructions. This should not be carried too far, and destroy all brooks. Therefore: (*a*) After the dam at Queensboro has been constructed no others should be made on this drainage. (*b*) That no clearing be done along the stream, and that open fields be planted to trees. (*c*) That Brook Trout be planted on a large scale and be given all possible encouragement. (*d*) That no fishing be allowed on these streams for a few years to assure complete stocking. (*e*) That this be made a trail stream.

Cedar Pond Brook.

1. Physical Conditions. This is the outlet of Cedar Pond, its headwarters having been destroyed by the pond. It is a steep succession of falls and pools and *is the most beautiful stream in the Park*. There is not an abundant supply of water during the summer.

2. Kinds and Abundance of Fishes. Brook Trout, *Salvelinus fontinalis* (Mitchill); Golden Shiner, very abundant; Long-nose Dace, not abundant; Black-nose Dace, very abundant; Cut-lip Minnow, abundant; Common Sucker, abundant; Tesselated Darter, *Boleosoma olmstedi* (Storer), abundant near Park boundary.

3. Conditions for Fish. The water volume is limited. Many large pools. The food supply is limited. Breeding condi-

tions favorable for all the species. Fish enemies not abundant. The stream is over-fished. Planting sites are easily accessible to the automobile road.

4. Policy for the Waters. This is the most beautiful trout stream seen in the Park, also the most favorable for trout. This stream is such a fine one that it should be made a trail stream, as is suggested for the upper Queensboro Creek.

5. Recommendations. (*a*) Plant with Brook Trout, in large numbers and in the small tributaries. (*b*) Discourage fishing for a few years, at least by adults. (*c*) Make this a trail stream.

American Fisheries Society

ORGANIZED 1870

CERTIFICATE OF INCORPORATION.

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish with power:

(*a*) To acquire, hold and convey real estate and other property, and to establish general and special funds.

(*b*) To hold meetings.

(*c*) To publish and distribute documents.

(*d*) To conduct lectures.

(*e*) To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

(*f*) To acquir and maintain a library.

(*g*) And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER	(Seal)
THEODORE GILL	(Seal)
WILLIAM E. MEEHAN	(Seal)
THEODORE S. PALMER	(Seal)
BERTRAND H. ROBERTS	(Seal)
HUGH M. SMITH	(Seal)
RICHARD SYLVESTER	(Seal)

Recorded April 16, 1911.

Presidents, Terms of Service and Places of Meeting.

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

1.	William Clift	1870–1872	New York, N. Y.
2.	William Clift	1872–1873	Albany, N. Y.
3.	William Clift	1873–1874	New York, N. Y.
4.	Robert B. Roosevelt	1874–1875	New York, N. Y.
5.	Robert B. Roosevelt	1875–1876	New York, N. Y.
6.	Robert B. Roosevelt	1876–1877*	New York, N. Y.
7.	Robert B. Roosevelt	1877–1878	New York, N. Y.
8.	Robert B. Roosevelt	1878–1879	New York, N. Y.
9.	Robert B. Roosevelt	1879–1880	New York, N. Y.
10.	Robert B. Roosevelt	1880–1881	New York, N. Y.
11.	Robert B. Roosevelt	1881–1882	New York, N. Y.
12.	George Shepard Page	1882–1883	New York, N. Y.
13.	James Benkard	1883–1884	New York, N. Y.
14.	Theodore Lyman	1884–1885	Washington, D. C.
15.	Marshall McDonald	1885–1886	Washington, D. C.
16.	W. M. Hudson	1886–1887	Chicago, Ill.
17.	William L. May	1887–1888	Washington, D. C.
18.	John H. Bissell	1888–1889	Detroit, Mich.
19.	Eugene G. Blackford	1889–1890	Philadelphia, Pa.
20.	Eugene G. Blackford	1890–1891	Put-in-Bay, Ohio.
21.	James A. Henshall	1891–1892	Washington, D. C.
22.	Herschel Whitaker	1892–1893	New York, N. Y.
23.	Henry C. Ford	1893–1894	Chicago, Ill.
24.	William L. May	1894–1895	Philadelphia, Pa.
25.	L. D. Huntington	1895–1896	New York, N. Y.
26.	Herschel Whitaker	1896–1897	New York, N. Y.
27.	William L. May	1897–1898	Detroit, Mich.
28.	George F. Peabody	1898–1899	Omaha, Neb.
29.	John W. Titcomb	1899–1900	Niagara Falls, N. Y.
30.	F. B. Dickerson	1900–1901	Woods Hole, Mass.
31.	E. E. Bryant	1901–1902	Milwaukee, Wis.
32.	George M. Bowers	1902–1903	Put-in-Bay, Ohio.
33.	Frank N. Clark	1903–1904	Woods Hole, Mass.
34.	Henry T. Root	1904–1905	Atlantic City, N. J.
35.	C. D. Joslyn	1905–1906	White Sulphur Spgs, W.Va.
36.	E. A. Birge	1906–1907	Grand Rapids, Mich.
37.	Hugh M. Smith	1907–1908	Erie, Pa.
38.	Tarleton H. Bean	1908–1909	Washington, D. C.
39.	Seymour Bower	1909–1910	Toledo, Ohio.
40.	William E. Meehan	1910–1911	New York, N. Y.
41.	S. F. Fullerton	1911–1912	St. Louis, Mo.
42.	Charles H. Townsend	1912–1913	Denver, Colo.
43.	Henry B. Ward	1913–1914	Boston, Mass.
44.	Daniel B. Fearing	1914–1915	Washington, D. C.
45.	Jacob Reighard	1915–1916	San Francisco, Cal.
46.	Geo. W. Field	1916–1917	New Orleans, La.
47.	Henry O'Malley	1917–1918	St. Paul, Minn.
48.	M. L. Alexander	1918–1919	New York, N. Y.

* A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

LIST OF MEMBERS, 1918-1919

Showing Year of Election to Membership

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The Governors of the several States:

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Arizona.....Thomas E. Campbell
Arkansas.....Chas. H. Brough
California.....William B. Stevens
Colorado.....Oliver L. Shoup
Connecticut.....Marcus H. Holcomb
Delaware.....John G. Townsend, Jr.
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Idaho.....D. W. Davis
Illinois.....Frank O. Lowden
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Kentucky.....James D. Black
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Maryland.....Emerson C. Harrington
Massachusetts.....Calvin Coolidge
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Minnesota.....J. A. A. Burnquist
Mississippi.....Theodore G. Bilbo
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Texas.....W. P. Hobby
Utah.....Simon Bamberger
Vermont.....Percival W. Clement
Virginia.....Westmoreland Davis
Washington.....Ernest Lister
West Virginia.....John J. Cornwell
Wisconsin.....E. L. Philipp
Wyoming.....Robert D. Carey

'08 Antipa, Prof. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.
'06 Besana, Giuseppe, Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy.
'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.
'93 Borodin, Nicolas, Petrograd, Russia.
'12 Calderwood, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.
'04 Denbigh, Lord, London, England.
'89 Fish Protective Association of Eastern Pennsylvania, 1020 Arch St., Philadelphia, Pa.
'04 Fryer, Sir Charles E., Royal Automobile Club, London, England.
'06 Grimm, Dr. Oscar, Petrograd, Russia.
'04 Kishinouye, Dr. K., Imperial University, Tokyo, Japan.
'08 Kitahara, Dr. Tasaku, Imperial Fisheries Bureau, Tokyo, Japan.
'88 Lake St. Clair Shooting and Fishing Club, Detroit, Mich.
'17 Mercier, Honore, Minister of Colonization, Mines and Fisheries, Quebec, Canada.
'09 Nagel, Hon. Chas., St. Louis, Mo.
'95 New York Association for the Protection of Fish and Game, New York City.
'08 Nordqvist, Dr. Oscar Fritjof, Superintendent of Fisheries, Lund, Sweden.
'06 Perrier, Prof. Edmond, Director Museum of Natural History, Paris, France.
'92 Vinciguerra, Prof. Dr. Decio, Director Royal Fish Cultural Station, Rome, Italy.

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'08 Higginson, Eduardo, Consul for Peru, New York City.
'84 Landmark, A., Insepctor of Norwegian Fresh-Water Fisheries, Christiania, Norway.
'84 Marston, R. B., Editor of the Fishing Gazette, London, England.
'09 Mohsin, S. M., Bengal Fisheries Department, Calcutta, India.
'89 Olsen, Dr. O. T., Grimsby, England.
'08 Potteau, Charnley, Lommel, Belgium.
'84 Raveret-Wattel, C., Director of Aquicultural Station at Nid-de-Verdier, 20 Rue des Acacias, Paris.
'84 Sars, Prof. G. O., Christiania, Norway.
'84 Solsky, Baron N. de, Director of the Imperial Agricultural Museum, Petrograd, Russia.
'10 Stead, David G., Fisheries Department, Sydney, New South Wales, Australia.

PATRONS

'14 Alaska Packers Association, San Francisco, Cal.
'15 Allen, Henry F. (Agent, Crown Mills), 210 California St., San Francisco, Cal.
'15 American Biscuit Co., 815 Battery St., San Francisco, Cal.
'15 American Can Co., Mills Building, San Francisco, Cal.
'15 Armour & Co., Battery and Union Sts., San Francisco,Cal.
'15 Armsby, J. K., Company, San Francisco, Cal.
'15 Atlas Gas Engine Co., Inc., Foot of 22d Avenue, Oakland, Cal.

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'15 Bond and Goodwin, 485 California St., San Francisco, Cal.
'15 Burpe and Letson, Ltd., South Bellingham, Wash.
'15 California Barrel Co., 22d and Illinois Sts., San Francisco, Cal.
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'15 California Stevedore and Ballast Co., Inc., 210 California St., San Francisco, Cal.
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'15 Caswell, Geo. W., Co., Inc., 530–4 Folsom St., San Francisco, Cal.
'15 Clinch, C. G., & Co., Inc., 144 Davis St., San Francisco, Cal.
'15 Coffin-Redington Co., 35–45 Second St., San Francisco, Cal.
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'15 Crane Co. (C. W. Weld, Mgr.), 301 Brannan St., San Francisco, Cal.
'15 Dodge, Sweeney & Co., 36–48 Spear St., San Francisco, Cal.
'15 First National Bank of Bellingham, Bellingham, Wash.
'15 Fuller, W. P., & Co., 301 Mission St., San Francisco, Cal.
'15 Grays Harbor Commercial Co., Foot of 3d St., San Francisco, Cal.
'15 Hendry, C. J., Co., 46 Clay St., San Francisco, Cal.
'15 Jones-Thierbach Co., The, Battery and Merchant Sts., San Francisco, Cal.
'15 Knapp, The Fred H., Co., Arcade-Maryland Casualty Building, Baltimore, Md.
'15 Linen Thread Co., The (W. A. Barbour, Mgr.), 443 Mission St., San Francisco, Cal.
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'15 Morse Hardware Co., Inc., 1025 Elk St., Bellingham, Wash.
'15 Pacific Hardware and Steel Co., 7th and Townsend Sts., San Francisco, Cal.
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'15 Sherwin-Williams Co., The, 454 Second St., San Francisco, Cal.
'15 Smith Cannery Machines Co., 2423 South First Avenue, Seattle, Wash.
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'16 Younger, R. J., Houma, La.

'99 Zalsman, P. G., Grayling, Mich.

ADDITIONAL LIST OF ACTIVE MEMBERS ELECTED AT THE ANNUAL MEETING, OCTOBER 8-10, 1919.

Albert C. Moore, 326 Frisco Bldg., Joplin, Mo.
C. R. Kalb, 1214 and 1215 Pierce Bldg., St. Louis, Mo.
Geo. Ashton, 1217 Pierce Bldg., St. Louis, Mo.
Roy S. Corwin, U. S. Fisheries Station, Homer, Minn.
R. D. Jordan, Drayton Plains, Mich.
Harley Moss, Comstock Park, Mich.
A. E. Hart, Comstock Park, Mich.
Claude Lydell, Comstock Park, Mich.
Albert Hazen Wright, Cornell University, Ithaca, N. Y.
H. S. Hedrick, Pierre, S. D.
Fred Fisher, Madison, Wis.
Clyde B. Terrell, Oshkosh, Wis.
Gus. Bernard, Atchofolaya, La.
Caleb Haley, 14 Fulton Fish Market, New York, N. Y.
The Post Fish Co., Sandusky, Ohio.
Charles E. Wheeler, Stratford, Conn.
C. F. Mischler, Sandusky, Ohio.
Edward L. Wickliff, 1309 Atchison St., Columbus, Ohio.
Wm. L. Glover, care Edison National Bank, Orangeburg, S. C.
W. D. Howser, Nashville, Tenn.
J. K. Renaud, 207 New Court Bldg., New Orleans, La.
Percy Viosia, Jr., Natural History Bldg., New Orleans, La.
R. D. Forbes, New Orleans, La.
J. J. Schrank, Sandusky, Ohio., Booth Fisheries Co.
H. C. Crossley, Put-in-Bay, Ohio.
E. E. Sherwood, Seattle, Wash.
Charles A. Bullock, Bullochville, Ga.
W. S. Vincent, Mammoth Springs, Ark.
Frank E. Hare, Manchester, Iowa.
Benj. Duckree, Wild Rose, Wis.
Talbot Denmead, 508 Munsey Bldg., Baltimore, Md.
E. Lee LeCompte, 512 Munsey Bldg., Baltimore, Md.
Wm. Holmes, Cosmopolitan Hotel, New Orleans, La.
Ralph P. Bradford, Dept. of Agriculture, Springfield, Ill.
A. P. Dapit, New Court Bldg., New Orleans, La.
Col. John H. Wallace, Jr., Montgomery, Ala.

RECAPITULATION.

Honorary	67
Corresponding	14
Patrons	53
Active	569
Total	703

CONSTITUTION

(As amended to date, recent changes in italics).

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERSHIP

Active Members.—Any person may, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership.

Any library, sporting or fishing club, society, firm or corporation may upon two-thirds vote and the payment of the regular annual fee, become a member of this Society and entitled to all its publications.

Life Members.—Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, become a life member of this Society, and shall thereafter be exempt from all annual dues.

Patrons.—Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50.00, may become a Patron of this Society with all the privileges of a

life member, and then shall be listed as such in all published lists of the Society. The money thus received shall become part of the permanent funds of the Society and the interest alone be used as the Society shall designate.

Honorary and Corresponding Members.—Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several States shall be honorary members of the Society.

Election of Members Between Annual Meetings.—The President, Recording Secretary and Treasurer of the Society are hereby authorized, during the time intervening between annual meetings, to act on all individual applications for membership in the Society, a majority vote of the Committee to elect or reject such applications as may be duly made.

ARTICLE III

SECTIONS

On presentation of a formal written petition signed by one hundred or more members, *or by vote of a Society together with the written request of the officers thereof*, the Executive Committee of the American Fisheries Society may approve the formation in any region of a Section of the American Fisheries Society to be known as the ——— Section.

Such a Section may organize by electing its own officers, and by adopting such rules as are not in conflict with the Constitution and By-Laws of the American Fisheries Society.

It may hold meetings and otherwise advance the general interests of the Society, except that the time and place of its annual meeting must receive the approval of the Executive Committee of the American Fisheries Society, and that without specific vote of the American Fisheries Society, the Section shall not commit itself to any expression of public policy on fishing matters.

It may further incur indebtedness to an amount necessary for the conduct of its work not to exceed one-half of the sum received in annual dues from members of said section.

Such bills duly approved by the Chairman and Recorder of the Section shall be paid on presentation to the Treasurer of the American Fisheries Society.

ARTICLE IV

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an editor, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

Vice-presidents of sections *may be called upon by the President to present reports of the work of their sections, or they may voluntarily present such reports when material of particular value can be offered by a given division.*

ARTICLE V

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE VI

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
   a. President.
   b. Secretary.
   c. Treasurer.
   d. Vice-Presidents of Divisions.
   e. Standing Committees.
5. Committees appointed by the president.
   a. Committee of five on nomination of officers for ensuing year.
   b. Committee of three on time and place of next meeting.
   c. Auditing committee of three.
   d. Committee of three on programme.
   e. Committee of three on publication.
   f. Committee of three on publicity.
6. Reading of papers and discussion of same.
   (Note—In the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VII

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

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U. S. National Museum

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OF THE

AMERICAN FISHERIES SOCIETY

DECEMBER, 1919

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The American Fisheries Society

Organized 1870 Incorporated 1910

Officers for 1919-1920

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Vice-President.....Nathan R. Buller, Harrisburg, Pa.
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Recording Secretary.....John P. Woods, St. Louis, Mo.
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Commercial Fishing.....J. Asakiah Williams, Tallahassee, Fla.
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TRANSACTIONS

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American Fisheries Society

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FISHERY PRODUCTS LABORATORIES AFFORD THE GREATEST PROMISE OF RELIEF OF UNSOLVED PROBLEMS AFFECTING COMMERCIAL FISHERIES.*

By Lewis Radcliffe,
Assistant in Charge, Division of Fishery Industries,
U. S. Bureau of Fisheries.

Agriculture, our greatest food producing industry, is abundantly supplied with experiment stations and other facilities for its advancement, with agricultural colleges and universities for the training of men and women for the industry, and highly skilled scientists to solve the difficulties obstructive to its fullest development. Its present high plane of perfection is due in large measure to the accomplishments of skilled workers in the field, in experiment stations and in institutions liberally supported by the federal government and individual states.

The fisheries, the other great food producing industry, have lacked and suffered for lack of advantages of this character. It is true that much has been done on the biology and natural history of fishes and in the restocking of our waters through fish-culture. But the field of preparation, preservation, transportation and utilization of fish and their products has been invaded only here and there, usually by the clever experimenter ordinarily without technological training, or the occasional scientist without a broad and comprehensive understanding or appreciation of the problems or adequate facilities for their solution. The ill effects of our neglect in this field are in evidence throughout the fisheries and many millions of pounds of valuable food are wasted annually. The methods in practice have been developed empirically, without definite knowledge of the basic principles governing the operation or their application to the best and most economical advantage. The fact that a method has worked, has sufficed. Fuel, time, labor, food and valuable by-products are wasted and fisheries remain undeveloped for want

*This paper was awarded a prize of $100.00 for the best contribution on the solution of problems affecting commercial fisheries work.

of satisfactory methods of preservation and utilization of the products. Even in the highly organized salmon industry there is insufficient knowledge of what actually takes place within the can, whether the time of processing is too long or too short.

There is need for a more careful study of the methods of capture, handling and distribution of fish to provide more economical, less wasteful methods, to prevent unnecessary destruction of the supplies in our waters and to furnish the consumer with a wholesome, attractive article of food in which the minimum of deterioration has taken place. There is need for exhaustive studies of the methods of preservation and utilization of fishery products, for the development of improvement and economies in practice, and for a much fuller development of uses for all products of the sea. There is need of determining definitely the dietetic qualities and peculiarities of the different species, of educating the consumer to the value of fish as food and to the best and most economical methods of preparation for the table. There is need for fully equipped laboratories and an adequate personnel for the solution of these difficulties. And finally, there is need for fisheries colleges to train men, and women as well, to enter the industry, to develop highly skilled technologists who shall devote their energies to the solution of these important problems. In the United States there are about sixty agricultural experiment stations and a considerable number of institutions for training workers in this industry. A year ago the fisheries were without such provision. Today there is one laboratory for this work and one college of fisheries.

THE FISHERY PRODUCTS LABORATORY IN WASHINGTON, D. C.

The war need for food conservation served the more forceably to emphasize the want of fishery products laboratories, fully equipped for the conduct of investigations. On July 2, 1918, the President of the United States made an allotment to the Bureau of Fisheries from the fund for the National Security and Defense for the erection and equipment of a Fishery Products Laboratory in Washington, D. C. As Assistant in Charge of the Division of Statistics and Methods of the Fisheries (now Fishery Industries), it has been the good fortune of the writer to have immediate supervision of the preparation of the plans for this building and its equipment, of the technological investigations

in this field and of making plans for future work, to all of which reference will be made.

In the absence of laboratories of this character for guidance, it has been necessary to devote much thoughtful study and care to the plans for the building and the selection of the various units of equipment. The Bureau's objective has been to provide equipment in which all possible factors could be controlled and recorded, that the trustworthiness of the final results of an investigation might be reasonably assured. In addition sight has not been lost of the value of the laboratory as a demonstration plant wherein visiting members of the fishing trade may view apparatus and processes of approved type in operation, and wherein the Bureau's employees may acquaint themselves with methods, processes and products of the fisheries to enable them the more intelligently to deal with problems in the field. A brief reference to the building and equipment which has been provided may be of interest in this connection.

The building, which was completed in June, 1919, and is nearly equipped, is 45 x 80 feet, two floors and an attic, of hollow tile and concrete construction. On the first floor there is a large mechanical laboratory, a refrigeration plant, chemical laboratory, incubation room, smokehouse and stock room. On the second floor there is a small laboratory, exhibit room, experimental kitchen and offices. The mechanical laboratory is equipped with a steam boiler, vacuum and compressed air pumps, hydraulic press, filter press, grinder, steam-jacketed kettle, lathe, etc. For canning purposes there is a complete plant for sealing tin cans by a double seamer, a retort with controlling and recording instruments, complete equipment for sealing and processing glass containers by a vacuum process and another for tin containers also by a vacuum process. For freezing fish in brine, a small experimental plant has been imported from Denmark and has been used to demonstrate this method to interested persons in the fisheries. This plant freezes fish by the Ottesen method and was the first of its kind to be brought in and used in this country. In addition to serving to demonstrate a new method to the trade, it will afford the Bureau's technologists means of investigating the various brine freezing methods and comparing them with the usual methods of freezing in air. For experiments in drying fishery

products there is an experimental dryer in which the heat, humidity of the air, and volume of air driven over the product can be controlled and measured and the weight of the product recorded. By this machine, the exact conditions governing the drying of different products may be worked out. For vacuum dessication, a small vacuum shelf dryer, with pedestal condenser and hollow shelves, so that steam, hot water, or brine can be circulated, and a vacuum pump capable of producing a high degree of vacuum, have been provided. With this apparatus it will be possible to dessicate such products as clam bouillon and to dry materials for analytical work. For experiments in smoking fishery products there is a built-in smokehouse of hollow-tile and cement construction, lined with white glazed wall tile and provided with a flue, iron door, ventilators, shavings pans heated with gas, long-distance recording thermometer and dampers for control of heat and ventilation.

The refrigeration plant is equipped with a five-ton carbon dioxide machine and recording instruments and three rooms of different temperature for storage and refrigeration. The chemical laboratory is provided with soapstone furniture, including hood, chemical cabinets, and has in its equipment a centrifuge, colorimeter, polarimeter, refractometer, viscosimeter, specific gravity balances, apparatus for determination of amino groups, for gas analysis, and other equipment required for the chemical study of materials and processes. Recording hygrometers and thermometers, thermostats, pitot tubes, pressure and vacuum gauges, will supply means for measuring and controlling the factors which influence the character of the product.

The incubation room is of hollow tile and concrete construction, provided with double doors and an ante-room. It is electrically heated with automatic controls for holding any temperature up to 112° F. and is equipped with a recording thermometer and hygrometer.

The exhibit room will afford a place in which to display fishery products and for demonstrations and meetings. The experimental kitchen is fully equipped for testing fishery products and determining the best methods of preparation for the table. Offices in the same building for the Division's personnel make for economy and efficiency in supervision and operation.

More detailed reference will now be made to some of the problems of the industry, most of which fall within the province of fishery products laboratories, and to investigations in progress.

SOME OF THE PROBLEMS IN THE INDUSTRY.

Capture, handling and distribution: In many cases present methods of capture are exceedingly wasteful, and millions of pounds of immature or unmarketable fish are destroyed annually. Laws intended to afford protection too often are more or less futile, wholly inadequate or unnecessarily obstructive. To illustrate, in certain waters tons of small butterfish are destroyed each summer. The form of these fish prevents their ready passage through the meshes of nets required for the capture of other food fishes, the law prohibits their sale for food or fertilizer, and as they are dead when taken from the nets, the loss is complete.

In some cases methods of capture are inadequate and private individuals lack the funds and facilities for large-scale experiments to effect improvement. The general use of the hook-and-line in the tuna fishery will illustrate. Thorough investigations by experienced workers conversant with the fisheries will undoubtedly develop improved forms of apparatus and means for lessening losses, will reveal the necessity for the exercise of greater care in taking the fish, of culling the catch where practicable and, where destruction is unavoidable, the need of permitting the use of the fish for some economic purpose.

There is equal need for effecting improvement in the methods of handling and distributing fish. For example, the practice of many small boat fishermen of leaving their catch in the bottom of an open boat exposed to flies and the direct rays of the sun is entirely too common. In the majority of cases it should be possible to remedy such conditions with little additional labor and equipment, in fact crude experiments recently made indicate that it is entirely feasible. Careful study should be made of the methods of preparation of fresh fish for market. For instance, one investigator has recently called attention to the point that eviscerated fish with the gills left in spoil more quickly than if the gills are removed and indicates the cause for this difference.

I believe that in some of our larger fisheries, experiments will prove it to be practicable to freeze the fish on the vessels as they

are taken from the water and, after transporting them in refrigerator cars, to distribute them in trucks with low temperature storage, placing them in the hands of the consumer in the original frozen state, a product when thawed out properly, quite comparable to the fish as taken from the water.

Preservation and Utilization. Conservation in its broadest sense has to do not with the saving of some waste product such as fish scales, but with the development of improved methods of doing things, methods which will result in the saving of expense, time, labor and materials. There is a very real need for conservation in the preservation and utilization of fishery products. Our knowledge of the underlying factors governing the preservation of fish is wholly inadequate.

The effects of icing, refrigeration and cold storage on different species and on the same species for varying conditions or periods of time, the factors of decomposition, including a study of the bacteriological phases of the subject, should receive thorough study, and practical application made of the results to effect economies and improvements in methods and the prevention or retardation of decomposition.

Abroad the freezing of fish in brine is being advocated. Of this method, it is claimed that fish may be frozen in one-tenth or less of the time required to freeze in air, and that a superior product is produced. This is explained by the fact that in rapid freezing the formation of water crystals in the tissues of the fish and the consequent disruption of cell-walls and losses of juices is prevented. The several methods of refrigeration and the qualities of the finished products, including the histology of the effects on the tissues, should be investigated that we may know definitely the merits and defects of the different processes and the physical and chemical changes which tend to impair the edible qualities of the frozen fish.

At first thought, the problems of drying fish by artificial means may appear quite simple. Because of the many factors which enter in to influence the character of the product, they are in reality highly complex. The temperature and humidity of the air and the volume of air passing per unit of time over the product affect the rate of drying. The manner of application of the warm air is also important, for if warm dry air is used from the start, the

product will be "case hardened" and slower drying will result than if the air at first were moist and cooler, the humidity being lowered and the temperature raised as drying progresses. Unless all these influencing factors are known and measured, it will be impossible to judge what can be expected from efforts to dry fish under circumstances different from those under which the experiments were conducted. With all these factors under exact and measurable control, the reproduction of the air conditions which prevail in any part of the country and the experimental drying of fishes under these conditions is a possibility. Remarkable progress is being made in the dehydration of vegetables. Until the subject has been investigated, who is able to forsee the possibilities of dehydration and dessication of fishery products?

The practice of preserving fish by smoking is very ancient and the products properly prepared may be numbered among the tastiest of foods. Yet how little attention has been given to the finesse of their preparation by trained technologists, how much of that offered for sale is only mediocre in quality. The varying composition of smoke from different fuels and at different temperatures, the penetration of the smoke, the subsequent fractional evaporation of the deposited smoke constituents from the fish, the possible addition of flavoring oils to the fuel, the coloring of the product, the prevention of mold on the smoked fish, possibilities of other improvements in keeping qualities and in technique of preparation, all should be given careful study.

The preservation of fish by means of dry salt, of pickles including brine, vinegar, etc., with or without the addition of spices and the prevention of spoilage of the prepared products, present a wide variety of problems, the solution of which would be of the greatest value to the industry. There has been need for information as to the relative values of the different grades of salt, of the advantages or disadvantages of the dry salting method as compared with brine salting, etc. Considerable losses are sustained due to the reddening of dry salted fish and the "souring" of the pickle in brine salted fish. The salability of fish is hurt by rust and production is curtailed on account of our inability to salt fish at high temperatures and therefore in warm climates.

Although the process of preserving foods by canning is more than a hundred years old, it is only within the last decade that this

important industry has begun to receive the interest of bacteriologists, chemists and technologists which it so richly deserves. In the canning of fishery products, present practices are greatly in need of careful study and standardization. Much of that which is now put into tin and glass can undoubtedly be improved upon and the markets of still other fishery products enlarged, with the development of suitable canning methods. Difficulties are encountered in the canning of crabs, shrimp, lobsters, sea crayfish, barracuda, rockfishes and sharks. The preparation of special products, such as caviar, the roe and buckroe of fishes, chowders, fish balls, fish loaf, fish sausage, and fish pastes, and their preservation in tin or glass are fruitful subjects for study.

The utilization of the waste products of the fisheries, the unutilized products of the sea, presents an alluring field for investigation and promises important additions to our resources. Mention may be made of the seaweeds, hydroids and possibly bryozoans, starfishes, fish scales, hides and membranes, fish waste and waste fish.

The annual production of fish scrap and meal in the United States will approximate 60,000 tons. During the first five months of this year over 32 millions of pounds of sardines were used for fertilizer at San Pedro, Calif., alone. While the practice of converting food fishes into oil and scrap or meal should be discouraged, it is quite within reason to believe that if all the waste, including that of the Alaskan salmon industry, were fully employed, our annual output might be doubled. Progress is retarded for the lack of suitable, low-priced machinery, capable of handling small quantities of waste economically. The annual waste of salmon offal has been estimated as representing the loss of several millions of dollars of marketable products. Because of its isolation, the Alaskan field presents a distinct problem in itself.

Fish scrap and meal under present methods of manufacture contain percentages of fat which are undesirable in fertilizers and objectionable in meal, compelling the exercise of greater care in feeding. There is at present no extraction apparatus which is at the same time economical and practical on a small scale and very few of the larger plants have felt able to install extraction machinery.

The annual production of edible fishery products in the United States, including Alaska, amounts to about 1,850,000,000 pounds, and the estimated per capita consumption is about 18 pounds. Both production and consumption should be increased. The chemical composition and food value of fish should be studied in greater detail. Such analyses as have been made reveal the need of analyses of fishes of different sizes and ages, from different localities, for different seasons of the year, with due consideration of the life history and habits of the fish. Experiments on the digestibility of certain species show a very complete utilization of the protein and fat in these fishes and confirms the value of fish as food and the need of its more extended use. These investigations should be extended to other species. There is a lack of information on the presence of vitamines, the medicinal value of various fish oils, the substances in fish that give taste and odor, etc.

The consumer should be acquainted with the pertinent facts brought out by these investigations, with the dietetic qualities of fish and with the best and most economical methods of preparation and cooking.

INVESTIGATIONS NOW IN PROGRESS.

Reference having been made to some of the problems of the industry, attention will be directed to investigations which are now in progress. These fall within the scope of or are dependent upon investigations of the fishery products laboratories.

Salting Fish.—Large quantities of fish preserved by salting are lost annually by spoilage and still larger quantities of fresh fish, for which there is no immediate market, are thrown away because of the risk of loss if cured. At times of high temperature or during the warm months in warm climates, such as obtains in the south, little or no attempt is made to salt fish, for lack of suitable methods of preserving the product. To determine the practicability of overcoming these difficulties and to gather more definite information about the basic principles governing the processes, an investigation was started over a year ago and has yielded significant results.

This investigation has shown that impurities in salt, such as the chlorides of calcium and magnesium, even in small quantities, have a marked effect on the process of salting and on the quality

of the product. Sodium chloride (common salt) penetrates the fish very rapidly and completely. Small amounts of calcium chloride, magnesium chloride or sodium sulphate added to the pure brine retard penetration. It may thus be seen how such impurities may adversely affect the proper preservation of fish in hot weather by prolonging the time of penetration until after decomposition has set in. As to quality of fish, pure salt produces a soft, more flexible meat, brownish or grayish in color. Calcium salts, which occur in commercial salts in sufficient quantities to affect the quality, retard penetration more than do magnesium or sulphur salts and cause the most noticeable whitening and hardening of the tissues. The investigation has also shown that salt penetrates the cut flesh of fish twice as rapidly as it penetrates unskinned fish.

By exercising unusual care in removing all blood and viscera, including roe and milt, and soaking the fish for thirty minutes, the investigator salted river herring at a temperature above 88° F., while the highest safe temperature at which salting may be done by methods in common practice is 60° F. Experiments indicate that the blood spoils at a temperature at least 25° F. lower than the spoilage temperature of the flesh of the fish. In the practical application of these methods it appears that the removal of all blood and viscera, including roe and milt, may have an important bearing in solving the problem of salting fish in warm climates. An investigation of the chemical changes taking place in the fat and protein of the fish during storage is in progress. As yet opportunity has not been afforded for the practical application of these results to determine in what ways they may be made to serve the industry.

Brine recovery.—Because of the usual practice of discarding used brine employed in the salting of fish, much salt has been wasted. The possibilities of producing better fish by the use of high grade salts as indicated above and the high cost of refined salts, make economies in the use of such salts imperative. For these reasons, during recent months attention has been given to the development of a process for the recovery of used brine, with such success that it now appears that it will be a practicable economical procedure. In this process, advantage has been taken of the adsorption of exceedingly fine precipitated particles of tasteless and inert matter which carry down most of not only the

suspended, but dissolved organic matter which is subject to decay. The fact that the precipitate does remove most of the organic matter has been demonstrated and an experimental plant has been installed at a commercial fish packing establishment. If, as the experiments indicate, this recovered brine can be rendered suitable for use again, the old brine used in preserving the fish brought to this plant will, when recovered, supply all the brine needed and will practically eliminate the firm's bill for salt, provided the amount of the brine used is sufficiently large to warrant the use of the recovery plant. In addition the process provides for the filtering off and drying of the precipitate, which is rich in protein and may be used for fertilizer or possibly for fish meal as an animal feed. Until the practicability of the process has been demonstrated to the satisfaction of all concerned, details of method will be withheld.

Canning fish.—Although noteworthy progress has been made in California in developing the tuna and sardine industries, there are still large, undeveloped fishery resources in the barracuda, mackerel, rock-fishes, smelts, etc. The Bureau of Fisheries is now attempting to develop suitable methods of canning these fish in its temporary experimental laboratory at San Pedro. A schedule has been worked out by which each species is subjected to sixteen preliminary methods of packing. After being held under uniform storage conditions for six weeks, these are examined as to appearance, quality, taste and the like, and analyzed to determine whether any important chemical change has taken place. Selecting the most promising of the preliminary packs for further tests, finished packs are then put up. To these are added the usual condiments or oils, or the fish are subjected to some prior method of treatment, such as smoking. These packs are then stored under uniform conditions and are to be examined at the end of three, six and twelve months, which is believed to be a reasonable time in which to determine keeping qualities.

Careful records of all operations are kept, making it possible to determine the cost price at any time, if the cost of the ingredients is known. Mackerel put up in olive oil, tuna style, and in cottonseed, corn or olive oil, after kippering, are particularly promising packs. In fact, packers who have examined these have been so impressed with the appearance of the product that request has

been made for the release of the methods at once. Methods for canning various fishes of other sections, such as the black drum, crevallé and menhaden, should be developed and improvements in existing methods made.

Experiments and demonstrations in fish cookery.—In the experimental kitchen, skilled domestic science workers have been determining the best methods of preparing new or little known fish and fishery products for the table. Among those receiving attention are groupers, black drum, menhaden, rockfishes, sea mussels, sharks, squid, tullibees, whale, whiting and the roes and buckroes of fishes. This information is for the use of the trade and the consumer.

In addition, practical lectures and demonstrations in the best and most economical methods of preparing and cooking fish have been given at various centers throughout the United States. In the course of a year, some 125 demonstrations were given and about 15,000 housewives were reached directly and many more indirectly. Housewives have been taught the value of fish in their dietary and the relative merits of many little known varieties. They have been encouraged to buy fish in the round, the viscera alone being removed, and to use the head, trimmings and bones, parts usually richest in flavor in making soups and gravies. Many of these fishes were purchaseable for from five to twenty-five cents less per pound than those the housewife was accustomed to buy and the additional saving of waste parts has meant real economy to the frugal homemaker. In place of the frying pan, the hot-oven method of cooking has been advocated. This eliminates practically all the unpleasant odors of cooking fish and affects economies in the use of fats and in time in cooking and serving. Through the medium of these lectures and demonstrations, many wrong impressions and false prejudices against the use of fish have been dispelled. Judging by the letters and reports from housewives, steward's associations, cafeterias, agents interested in food conservation and demonstration, fish retailers, wholesalers and producers and the publicity given the work by the press, this has been one of the most beneficial activities taken up by the Bureau of Fisheries in recent years. It will be noted that the experimental work of the laboratory kitchen is coupled with practical demonstration in the field. This is important,

for of what value is an exhaustive scientific investigation or principle if hidden away in a musty book out of reach of those who might put the principle to work for the betterment of themselves and mankind?

Marketing.—It is important that experiments and demonstrations illustrating the food value of fishes, particularly the little known forms, should be accompanied by aid in the development of larger markets for fish. This function has not been neglected. For example, the producers of groupers have been receiving aid in extending the markets for these fishes. On the fishing banks in the Gulf of Mexico, groupers are more abundant than the highly prized snappers. The demand for the latter is in excess of the supply, while that for groupers is usually not sufficient to care for more than half of what the fishermen could bring in, with the result that quantities of these wholesome, white-meated fishes are wasted and the fishermen lose valuable time in search of the choicer snappers. The trade has been furnished an illustrated placard recommending the use of these fishes and a cookbook for distribution to consumers. In addition, agents skilled in the marketing of fish have actively assisted in increasing the consumption of these fishes, giving special attention to the restaurants and cafe trade.

The black drum, a species particularly destructive to oysters, is in little demand. Experiments in canning this fish indicate that it is most excellent when preserved in this form. Information has been gathered as to its habits, places of abundance and methods of capture. This information is being made available to the trade to further the development of the fishery.

The whale fishery has also received attention and in 1918, 30,000 cases of the meat were canned and 195 tons frozen for market, the latter being wholly insufficient to supply the demand. Provision has been made for a pack of 50,000 cases and for freezing 1,000 tons of this inexpensive, wholesome food this year. The production and use of various other products have been stimulated.

Waste products.—In an effort to furnish a new source of supply of leathers, at a time when such materials were becoming scarce and high in price, the development of a fish leather industry, including the use of the hides of other unutilized aquatic animals was undertaken. Nets suitable for the capture of sharks in

commercial quantities have been perfected, methods of removing, curing and boxing the hides in a manner acceptable to the tanner ascertained and the information supplied to inquirers. Tanners have been supplied with hides for experimentation without cost and encouraged to overcome difficulties in tanning. Tests have been made as to tensile strength and other qualities of fish leather as a basis for comparison with other leathers, and manufacturers interested to determine to what uses such leathers are best suited.

As a result the production of fish leather is an established fact. One company has a tannery devoted to the production of such leathers and fishing stations for the assemblage of raw hides, and a second company advises that it is collecting large stocks of hides and equipping a tannery in which to tan and finish such leathers. Other companies are still experimenting with these hides. Leathers which are soft and pliable, of adequate strength for many uses, are being produced and used for the manufacture of bags and the like. It is understood that the supply is entirely inadequate.

Our present annual production of fish oils is in the neighborhood of six million gallons. The demands for and uses of such oils are increasing and the prices are attractive. For illustration, because of the scarcity and high price of linseed oil, makers of paints and varnishes are concerned about the supply of drying oils and are turning to the fisheries to determine the suitability of such oils for their purposes and the proper available supplies of oils. In line with the Bureau's efforts to build up a fishery for sharks, in addition to saving the hides for leather purposes it is urging the extraction of the liver oil to supply the deficiency and the conversion of the balance of the fish into scrap for fertilizer. Samples of the liver oils of various sharks and rays are being assembled and subjected to careful chemical analysis to ascertain more definitely their properties and to what uses they are best suited.

An effort is being made to meet the need for new and enlarged sources of supply of protein feeds for hogs, cattle and poultry. As experiments made by the Bureau of Animal Industry indicate that fish meal is a satisfactory feed, fully the equal of tankage for feeding purposes, the production of this product is being encouraged. On the east coast where but little has been made, methods for producing a satisfactory meal from menhaden have

been developed and companies interested in its preparation, with the result that they are prepared to make from 2,000 to 5,000 tons this year if sufficient farmers can be acquainted with its merits and interested to purchase it.

NEED OF ADDITIONAL FISHERY PRODUCTS LABORATORIES.

The Washington laboratory is intended for the study of general problems. It is also specially equipped for the careful investigation and analysis of the properties of fishes and fishery products, such as oils and fertilizers, a place in which to make an examination and tests of the manifold products referred to the Bureau. Therein its technologists may try out new ways of operation and methods suggested by their visits to the fishing centers and receive valuable training which will enable them the better to cope with field problems. Consideration of the problems needing and receiving attention will, I think, convince you of the need of this laboratory and that it should render efficient service to the industry.

There are many special problems which of necessity must be conducted at the seat of the industry. For these, provision should be made for several additional fishery products laboratories, possibly one for each of the main geographical divisions of the fisheries. In addition to assisting those in the industry to effect economies and improvements in methods of preparation of fishes, of the region for market, in preservation, in the prevention of spoilage and in developing new or untried methods of preservation and uses for by-products, such laboratories might profitably give attention to the perfection of apparatus and methods of capture and handling, to the study of the needs of conservation, that timely attention may be called to dangers of depletion or ultimate exhaustion, and the prevention of unnecessary waste or destruction. There is a growing demand for such work. To meet this in so far as has been practicable, a small temporary experimental plant has been established at San Pedro, California, especially for the developing of methods of canning mackerel, barracuda, etc., to which reference has been made.

If such laboratories are to produce the results for which they are intended, skilled technologists must be employed for the technological work. These should be university graduates in chemistry and technology with training in chemical technology in

the preparation of foods, animal and vegetable products, and laboratory management, with practical experience in the technology of fisheries, plant design and machinery. If men with these qualifications are to be obtained and retained, they must be paid salaries comparable to those received by men in similar lines of work, for example, the technologists of the National Canners Association, meat packers, sugar producers, etc. In most cases, it will be necessary to employ men with the necessary basic training and to develop them for the fisheries work. Their value should greatly increase with length of service. If on the other hand the training of new men is constantly required, the output of the laboratories will be greatly curtailed and their effectiveness minimized.

Further, the opportunities for co-operation with trained workers in universities and other laboratories should not be lost sight of. For illustration, in the course of investigations of technical or commercial processes, it often happens that the work is hampered or delayed for lack of pure scientific data. By close co-operation with other institutions and acquainting them with the laboratory's needs, they may be able to assign the problem in pure science to one of their investigators and thus relieve the products laboratory worker of the necessity of dissipating his energies on collateral investigations.

In conclusion, the writer is convinced that the development of the fishing industry has been seriously retarded by the lack of facilities comparable to those supplied to agriculture, and that fishery products laboratories, fully equipped and with adequate provision for personnel, afford the greatest promise of relief of the unsolved problems affecting commercial fisheries.

THE GROWTH OF FISHES.

By Professor A. G. Huntsman,
University of Toronto, Biologist to the Biological Board of Canada.

"Greater production" is the cry of the present day and the imperative need of the hour. In the realm of living things, either plant or animal, this production is virtually synonymous with growth. The desired product is the result of growth, and the problem of growth is, therefore, one of extraordinary interest to us. With the broad lines of this problem we are familiar through our knowledge of the life history of man, if from no other source. The early part of life is the growing period and under suitable conditions, such as with sufficient food of certain kinds, sufficient water and air, a temperature not too extreme, and no unfavorable circumstances of poison or disease, the growth of man proceeds uninterruptedly, but with gradually decreasing intensity, until the period of maturity is reached, when general growth ceases.

The problem of growth is an enormously complex one and has ever new angles. This is shown by the comparatively recent discovery in certain foods of special substances, to which the name of vitamines has been given, and which have a wonderful effect in accelerating growth. That, from the standpoint of growth, we can improve upon what nature shows us, is demonstrated by the use of the method of forced feeding in poultry and of caponization for cockerels.

We are greatly handicapped in our study of growth in fishes by their living in the medium of water, to which we have only imperfect access. It is a comparatively easy matter to watch the growth of plants, and in the case of animals, if they live on land, one can keep them under almost constant observation. But we can see only a short distance into the water, and even that view is interrupted by every breeze, however slight, that agitates the surface. Consequently our knowledge of the growth of fishes has been extremely limited, for until very recent years it was a moot point as to the age attained by the commonest fishes, except for a few that could be kept in restricted bodies of water under more or less artificial conditions.

The special difficulties of the case have been overcome in indirect ways. The statistical method was popularized by C. G. J. Petersen towards the close of the last century. In this method the population of a certain kind of fish in a given locality is examined by taking samples at random and measuring these. It is found that, if the sample be comprehensive enough, the individuals fall naturally into groups according to size, the groups of smaller size being most distinct. Seeing that the fish has a definite spawning period, which is annual, each group is to be considered as consisting of fish born in a certain year, that is, belonging to a certain year-class. One group will consist of those individuals that are in their first year, another of those in their second year, and so on. In this way the average size at any given age may be found. Not only this, but we may follow the growth of any group by taking samples from time to time and determining the average size of that group, from which data the average increase per unit of time can readily be calculated.

This method has disadvantages. It is often difficult or even impossible to obtain comprehensive samples, owing to segregation of different ages. Also, if the growth be slight, compared with the amount of individual variation in size of those of the same year-class, the groups overlap in size and cannot be distinguished. The discovery of another method has been, therefore, of the greatest value.

Over three centuries ago, when the microscope was first invented, Van Leeuwenhoek, the pioneer microscopist, living in the eel-eating country of Holland, discovered not only that eels have scales, but that their scales show rings, which he interpreted as indicating years. Only at the beginning of the present century was this discovery extended and used in the study of the life history of fishes.

The scales are not the only parts of the fish that exhibit such annual markings. Similar lines to those of the scales can be seen in the ear-stones and in the bones, particularly the vertebrae; but in the majority of fishes the scales have proven to be the most valuable of all the parts in this respect. It is, indeed, astonishing for one to be able, as I was recently, to say on returning home and noticing a fish scale adhering to the oilcloth of the kitchen table: "You have been having a five-year old whitefish to eat lately."

One might have gone further and have given its probable size and perhaps even the name of the lake in which it was caught, as well as other features of its history. It is known that the arrest of growth due to disease or other causes is recorded in the scales. C. K. Gilbert maintains that the salmon from different rivers on the Pacific coast can be distinguished by the peculiar effect of each river on the growth of the salmon in early life as shown in its scales. E. Lea has shown that the herring of the year-class of 1904 had a peculiar growth in their third year, in the north of Norway, that made it possible to distinguish them from those of other regions. A certain Atlantic flatfish grows so slowly in the Gulf of St. Lawrence, as compared with the Bay of Fundy, that it was possible for me to correct a dealer as to the source of his fish after an examination of the scales.

The formation of annual rings or zones in the scales is dependent upon a yearly periodicity in growth. "Warm-blooded" or, more strictly speaking, homoiothermal animals are in large measure independent of outside temperature, for they are able by means of a heat-regulating mechanism to maintain an optimum temperature in their bodies. Poikilothermal or "cold-blooded" animals, like plants, vary in temperature with their surroundings, and their activities, including growth, must await a favorable season. In the majority of fishes that have been investigated there is a diminution or arrest of growth during the cold part of the year, and therefore, the age rings on the scales are to be interpreted as "winter checks."

When these checks can be seen, the determination of the age of a fish is simple enough, but caution must always be exercised. In fishes, such as the salmon, which have a long period of embryonic development including the winter season, it would not be expected that this first winter would be shown on the scales. But, even after hatching, a considerable time must elapse before the scales begin to appear in the skin of the young fish. It is at the time of metamorphosis from the larval or postlarval condition to the final stage, that the scaly coat makes its appearance. Even in the fishes that have a rapid development, such as the saltwater herring, if spawning takes place in the late summer or in autumn, the young fish will remain scaleless during the first winter. Not only so, but a spring-spawning fish may pass the first winter with many

of its scales undeveloped or so small that no check is registered. Another difficulty arises when the growth for any year is slight, for the checks may come so close together as to be indistinguishable, which is particularly the case in the later years. Unlike so many animals with which we are familiar, the majority of fishes do not reach a definite full size beyond which growth ceases; but under favorable conditions, many continue to grow throughout life, although at a greatly diminished rate when well advanced in years. In these the size attained is limited only by the rate of growth and the duration of life. Carp and pike are reputed to have lived for as long a period as one hundred years, but if the conditions are unfavorable no great size will be attained. It is doubtful whether the age of such long-lived fishes can be determined from the scales, although the annual markings do show that certain fish have lived for at least a quarter of a century.

When the checks are definitely marked, it is possible from measurements of the distances between successive winter checks to determine the amount of growth in each year of the life of the fish, as has been practised by J. Hjort and other Norwegian investigators working with him. Here also it is important to use discretion in our interpretation. We have found that the ratio of the growth of the scale to the growth of the whole fish is a changing one, but by allowing for this a fair approximation to the actual amounts can be made.

The scales of certain fishes exhibit, in addition to the checks, a varying width for certain, usually concentric, structures known as circuli. The interpretation of the width of these as depending upon the rapidity of growth would indicate that growth is more rapid during the first part of the growing season, which view is confirmed by other methods of investigation. The seasonal growth may be studied by the statistical method, the scale method, or by a combination of the two, as well as by the method of direct observation, when this is practicable. Great differences in seasonal growth have been found. Many of our fishes begin rapid growth in spring or in early summer, but we have found that a certain flat-fish (*Hippoglossoides*) begins the season's growth in the Bay of Fundy in the winter when the temperature of the water where it lives is still going down. This fish is remarkable because of being able to grow when the temperature is below 32° F. Although

the Bay of Fundy, from its having a higher bottom temperature than have other parts of our Canadian eastern coast, promotes the most rapid growth in this fish of which we have knowledge, it is unfavorable for it in other ways, giving a slower growth in later life, a lower maximum size, an earlier death, and no opportunity for successful breeding.

We have perhaps surveyed the ground sufficiently to show what an interesting and virgin field of research has been opened up by these recently developed methods for the growth-study of fishes. The importance of this work should be evident to everyone. Much of our fishery legislation will be altered by the results obtained in it, and it should show among other things beyond what age it ceases to be profitable to leave the fish of a certain species in the water, how intensively it is wise to fish a certain species, and how long it should take for recovery from overfishing.

(Read by Dr. E. E. Prince, Commissioner of Fisheries of Canada.)

Discussion.

Dr. E. E. Prince, of Canada: When Dr. Hjort, the Norwegian investigator referred to in the paper, visited Canada and the United States, he did some work for the Canadian Government. By studying the scales of the sea-herring, he determined that some of these fish were actually twenty years old. It seems remarkable that small fish, such as the sea-herring, should reach that age.

Dr. Huntsman was particularly interested in these studies of Dr. Hjort and continued the investigation on the ear-bones or otoliths, which show the growth year by year, and also on the rings of growth on the vertebrae. He found some reason to question the determination of the age by the scales alone. There should be a combination of all three kinds of study to determine the age with accuracy. If a large number of fish from any area are taken, you can almost determine how many years are represented in the mass, and when the earbones, scales and vertebrae confirm this you can be certain as to the results.

Mr. J. W. Titcomb, of New York: If I remember rightly, Dr. Hjort and our U. S. Bureau of Fisheries are agreed that the scales behind the pectoral fins, where there is no abrasion, are the ones to be used in determining the age.

Dr. Prince: That is a very good point. There is a certain amount of wear and tear on the scales and they cannot be taken haphazard, but must be selected from parts where there is the least abrasion. On some fish the rings on the scales are so distinct and regular that the determination of the age is more easy in some species than in others.

FRESH WATER MUSSELS AS A FISH FOOD.

By D. Lydell,
Comstock Park, Michigan.

During the time when the price of liver, etc., was almost prohibitive for feeding fish, we began the search for a substitute. We found tons of fresh-water clam meats going to waste along our rivers in Michigan, so conceived the idea of using them for fish food. Some of the fresh meat was taken to our hatcheries and ground up and the adult fish seemed to take it very readily, but it was impossible to get the fresh meat fine enough for our fry and fingerlings.

Fresh clam meats do not keep for any length of time, and the season for collecting them covers only a few months in the summer, so we attempted to devise a way to preserve the meats for feeding throughout the year. Drying seems to be the only method. At first we dried a few of them in the sun, which is a very successful way, providing you do not have cloudy or rainy weather, in which case the clams will sour very shortly and be unfit for feeding. Several experiments and methods were tried, but the most practical and economical drier and one that can be moved to any point along the stream where the clams are collected, is a box-like arrangement 3 or 4 feet square, and 5 or 6 feet in height, fitted with trays made of quarter inch galvanized wire. These are filled with clams and set directly one above the other. An old-fashioned box stove is put in the bottom and fired with wood or coal, or refuse picked up along the stream. In this way the clams are dried in nice condition in about 20 hours. These clams, when thoroughly dried and stored away, will keep indefinitely. I have some here on exhibition that were dried in 1916. By placing them in warm water, they will return to their natural size in about 15 hours.

The next problem was to get the clams fine enough for our small fish and grinding seemed to be the only method. After some experiments we found they could be ground up into a nice meal. This meal when put into hot water swells up very quickly, and a very little of it makes a large amount of food, and it is fine enough to feed to the smallest fry.

Other experiments were then tried in regard to feeding the meal to our adult fish. This we accomplished by making a thick mush, similar to a corn-meal mush, simply by stirring the meal into boiling water slowly until the mush was as thick as it could possibly be stirred. This was set away to cool and then run through a grinding machine or a press, with holes in it the size of the food required. The food came through the press or grinder in wormlike masses. We found our adult fish would take this a great deal more readily than they did the ground up clams.

REDUCING THE DEATH RATE AMONG OUR STOCK FISH.

During the summer of 1918 and 1919, clam meal was the only food used to feed all of our fish at the Mill Creek Station, and the death rate has been reduced to a minimum. Not enough fish died in 1919 to justify us in keeping a record of them. Prior to 1918 the death rate among our stock fish, such as bass, blue-gills and perch, was always about 25%. From the Drayton Plains Hatchery, in Michigan, comes the following report:

"I have lost less than 20% of my blue-gill breeders this season, where every season before we have lost 75% and I firmly believe that it is all due to clam meal diet. We have fed it almost clear to both the large and small fish, and they have certainly done well on it. J. L. Brass, Overseer."

At Mill Creek Station this season 89,000 blue-gills and 57,000 perch were raised to the fingerling stage. The last of these were distributed on October 4th, when they ranged from 1½ to 5 inches in length. At first they were fed five times a day, but later only one feeding was given each day.

CLAM MEAL AS A NATURAL FISH-FOOD PRODUCER.

During the season of 1918, when our ponds were drawn down and being cleaned, I scattered about 25 pounds of clam meal around the shores of one pond. Several days after the ponds were re-filled with water, I noticed large quantities of crustacea, which seemed to be more abundant in this particular pond. Whether this was due to the clam meal, of course, we do not know.

During the season of 1919, this experiment was carried further, part of our ponds were treated and the others were not. The

result seemed amazing, as though there was twice as much natural food in the ponds treated as in those not treated. Whether this natural food supply is increased, or simply fed by this meal, is a matter, I think, for science to decide.

These are only some facts that have been discovered and jotted down to get information and provoke a discussion. Several tons of this food has been sold by Comstock Park Fish Food Company, and possibly some of the men that have been using it are present at this meeting. If so, I would appreciate hearing what success they have had, how the meal has been prepared for use, etc.

The Wistar Institute of Anatomy and Biology, of Philadelphia, Pa., seems to be having great success in feeding it to their colony of white rats. They claim that their death rate has not only been reduced, but that their litters have been increased.

Discussion.

MR. GEO. H. GRAHAM, of Massachusetts: I would like to ask Mr. Lydell if he ever fed this meal to trout or salmon.

MR. LYDELL: I have not had occasion to feed it to brook trout. We fed it exclusively to chinook salmon one season until they were about six inches in length. They did better than on liver and there were only thirteen deaths among 600 fish in one small pond.

A MEMBER: What is the difference between the cost of liver and this preparation?

MR. LYDELL: I cannot say exactly, but this meal costs about ten cents a pound and we feed less than one-third as much of it as we would of the liver. Besides we can rear the fish better on it.

MR. GRAHAM: To what other fish can it be fed?

MR. LYDELL: We have fed this food exclusively for two years to yellow perch and large- and small-mouth black bass.

The mussels are shipped to us from the button factories. After they are dried they are stored in that condition. When we want them for food we put them in the dryer and then run them through the grinder, which is connected with a gasoline engine.

MR. GRAHAM: Is there any limit to the amount we can get?

MR. LYDELL: I should judge that we could have secured forty or fifty tons within thirty miles of Grand Rapids.

MR. GRAHAM: What is the name of the company and are they now selling the meal?

MR. LYDELL: The Comstock Park Fish Food Company is preparing now to handle the meal in a commercial way. (Mr. Lydell then exhibited samples of the dried mussels and various grades of the meal intended for use with fish of different sizes.)

Mr. G. C. Leach, of the U. S. Bureau of Fisheries. I believe the clam meal is a very good fish food. I have ordered fine clam meal and the whole clams with the intention of having five or six of our superintendents try them out in the way Mr. Lydell has described. We have used it in Washington, under ideal conditions, with good success, feeding nothing else but clam meal, mixed with water into a thick mush. We fed salmon, brook, rainbow and steel-head trout, whitefish and perch.

When the meal was dropped on the water some fish were quite wily, but later, when it had settled to the bottom, they sucked it up. At the stations where bass and other such fishes had been fed on beef heart they did not take readily to the dried clam, but I believe that they could have been trained to take it. We have not had a full report from the stations that have used the meal, so I cannot say as to the results, but in Washington we found it satisfactory. What results did you have, Mr. Seagle?

Mr. Geo. A. Seagle, Wytheville, Va.: After feeding the young trout on beef heart and liver they did not take to the clam meal readily, but I believe that if we feed them on the meal first and nothing else they will take it readily enough.

Mr. John P. Woods, St. Louis, Mo.: I wish to give the benefit of some experience I had during the years 1914 to 1918. When seining our ponds in the summer time we took large numbers of crayfish. These were run through a grinder with stale bread and substituted for other fish food. When this could be had there was a great demand for the crayfish substitute.

A Member: The grinder we use is the same as for grinding beef hearts. By using the fine plates and mixing with corn meal or low grade flour or shorts we get any desired length or thickness we desire. But I think that probably the greatest success with the clam meal, as Mr. Lydell suggests, is as food for Daphnia, by scattering it around the edges of the pond where it serves as food for the small organisms.

Mr. Leach: We use crayfish a good deal at the Ocean Station, grinding it and mixing with low grade flour or shorts. It makes a very nice food.

Prof. E. E. Prince, Commissioner of Fisheries of Canada: I believe the fish get rather tired of heart or liver when fed continuously, though it appears, as Mr. Seagle says, that they don't take readily to new food when offered. But experiments in fishing show, in the east at any rate, that fish can be caught more readily by a change of food. For instance, if the fishermen have been using soft-shell clams and then change to mussels they will do better. In one locality I know sea-anemones were used as a change and the boats using them caught more fish than the other boats, as though the novelty attracted the fish.

But there is one thing about Mr. Lydell's clam meal which I think noteworthy. It is a diet that embodies a variety of foods. The mussels contain liver, muscle tissue, connective tissue, etc., and I think such a mixed diet has much to do with the success of this food and the healthy character and growth of the fish.

Mr. N. R. Buller, of Pennsylvania: I would like to inquire in this connection whether the increase of Daphnia in ponds in which this meal is scattered is not simply because the meal acts as a fertilizer. My impression is that the Daphnia feed on algae. In other words doesn't this meal simply furnish ammonia and ammonium nitrate which could be as easily and more cheaply furnished by commercial fertilizers? Doesn't it act only as a fertilizer?

Mr. Lydell: That may be true. It is up to some one better versed in science than I am and I only know the results we obtained. In regard to the trouble experienced in feeding the clams to bass, I may say that if the whole clam is scalded and ground, you do not get the worm-like masses. The feet of the mussels are very hard and do not soften readily. By being pulverized in the dry condition and then soaked, that part is prepared so the fish will eat and relish it. An eighth of a teaspoonful of this finest meal put in a cup of hot water will make as fine a bouillon as you ever drank.

Mr. Killian, of Maryland: There is a preparation being manufactured from oysters at Hampton, Va., and sold under medical recommendation as human food. It is the very same proposition.

CHANGING FOOD CONDITIONS OF THE TROUT FAMILY.

By James Nevin,
Wisconsin Conservation Commission, Division of Fisheries.

FISH AND GAME WITHIN THE STATE ARE THE PROPERTY OF THE PEOPLE.

The degree of success achieved in planting fish is determined by the conditions of the water in which they are planted. Some lakes and streams are more productive of fish and the life upon which the fish feed than others. The problem with which we are confronted is, how can those conditions be maintained? The farmer who sows and reaps without returning anything to the soil soon has a barren field. We have been planting fish in streams for years and the time has arrived when many of our streams cannot support greater numbers of game fish and the question to be solved is, what can be done to restore these streams to their former pristine conditions so they can be stocked to meet the increased demand?

The principal food of large and small trout and which is in most all spring water fed streams, is the caddis or the May-fly larva. The May-fly larva lives under water and adheres to the stones on the bed of the stream till ready to emerge in the adult state. The caddis larva is a wormlike creature and looks as if it might be encased in bark from the tree or an alder bush. Then again, in most all of our spring water holes, where water-cress will grow, there will be found vast numbers of fresh water shrimp all along the stream clinging to roots, logs or stones as they drift along down the stream. These the fish feed upon.

Brook trout prefer streams that contain hiding places and clear spring water with a maximum temperature of about 60°. In many of the counties of the state intensive farming has caused the removal of brush and trees from the banks of streams, destroying the conditions that provided natural haunts for the fish. Many farmers set aside for pasture that portion of their farms through which the stream flows. Cattle and hogs wade and wallow in the stream, making it unfit for trout, with the consequence that the fish are driven away or die. After a heavy

rainfall, the wash from cultivated fields also makes the streams unfit for trout. It would be a good idea for farmers and others interested in fish and fish life to plant willow and tag alder along the streams, making shade for the fish.

I have one trout stream in mind in Wisconsin that in years gone by attracted more sportsmen and men of note than any other. Some thirty years ago when visiting this stream, I observed that it was bordered by a dense forest of pine and hemlock trees. Trees frequently were found fallen across the stream and logs and brush formed pools—ideal hiding places for trout. Several well-to-do sportsmen from nearby cities bought small tracts of land along the stream and built elaborate summer homes and others built cottages, and in time there got to be quite a settlement along the stream. Practically all of the marketable timber had been cut, except the small areas that were privately owned and used as sites for summer homes.

The time came when the sportsmen thought the river ought to be cleared of all brush and logs so they would be able to fish from the bank of the stream and also be more convenient to wade to catch the fish. All those having an interest in the stream got together and raised a sum of money to have the stream cleared of all logs and brush. A man was hired to do the work and the result was not what the sportsmen desired. The condition of the stream was so altered and the former haunts of trout removed, that today there is not one trout in the stream where formerly there were twenty. The man who cleaned the stream kept a resort and acted as guide for the accommodation of the many sportsmen who visited the stream each year. Two years ago he made the remark that he had been guilty of ruining his own business and the reputation of the stream by accepting the contract to clean out the river. He drove the fish away by destroying their hiding places.

Personally, I do not feel that we are getting as good results from trout planting today as we did twenty or thirty years ago. In the earlier days when the streams were first stocked there was an abundance of insect life in the water, upon which the trout seemed to thrive and grow much faster and larger than they have in the past fifteen years. In the earlier times small fish, such as shiners and others, on which the larger trout fed, were more

numerous. Then too, there were not as many fishermen in the early days to deplete the streams. With the automobile for transportation, a fisherman can cast his line in many trout streams during the day.

The theory of some sportsmen that trout of fingerling size only should be planted to get the best results is not proven by the results of experience. Brook trout are cannibalistic and are not particular what variety of fish they eat. When fry are planted under instructions in the smaller streams their natural instincts prompt them to seek shelter from their enemies. If they are kept in the ponds and fed by the hand of man until they have reached some size and then turned loose, they have lost a part of their instinct and will not seek shelter when in danger. Hence they become an easy prey to their enemies.

Twenty-five years ago the Wisconsin Commission planted 800 lake trout two years old and over, averaging in weight a pound or more, in Lake Mendota. The morning following the planting four of these trout were taken from the stomachs of pickerel that had been speared during the night by Mr. I. C. Troan. The trout taken from the pickerel were exhibited in Dunning & Sumner's drug store, Mr. Dunning being at that time president of the Fish Commission.

BROWN TROUT.

The brown, or Lochlevin trout, is not native to this country, but was introduced some thirty years ago by the U. S. Bureau of Fisheries. Through the Bureau of Fisheries various state commissions secured limited quantities of eggs from which to grow a stock of breeders, these in turn to furnish a supply of eggs to produce fry with which to stock public waters.

The brown trout is a very hardy and gamey fish and grows to a large size. As a table fish its eating qualities are surpassed by none. For a number of years we did not make much of an effort to propagate this particular species, as it was reported that the brown trout was cannibalistic and destructive to other fish. Our experience and observations do not bear out the report. They are no more destructive of fish than the brook trout or other species of trout. We have been planting from 100,000 to 500,000 each

year for the past twenty-five years; they were mixed and distributed along with the brook trout fry; hence they can be found in most of the streams where brook trout were planted. The brown trout have thrived in many streams and a report has been received of a single fish being caught that weighed seventeen pounds. One fisherman caught three in one day, that weighed thirty-six pounds, from the Kinnickinnic River in Pierce County. The Kinnickinnic seems to furnish ideal conditions for this variety of fish and at present probably contains more brown trout than any other stream in the state.

The demand for the brown trout for planting is constantly on the increase, more especially for the streams in the southern half of the state. Some people are of the opinion that the brook trout is not doing as well in our southern streams as formerly and are ordering brown trout to take their place. To meet the increased demand, we have endeavored to increase our stock of breeders. So far this season we have taken over 1,000,000 eggs, the most we have ever taken in one season.

THE GREAT DECLINE OF THE OYSTER INDUSTRY IN CONNECTICUT AND RHODE ISLAND.

By Henry C. Rowe.
Daytonia Beach, Florida.

The Oyster Industry of Connecticut and Rhode Island is progressing rapidly toward extinction.

Between 1875 and 1881 a vast oyster farming industry was developed in the State of Connecticut, which furnished for over thirty years employment for thousands and food for millions. Later, the same men, who created the Connecticut enterprise, extended their operations into Rhode Island waters. During the past ten years, however, the industry in both of these States has been diminished by more than one-half and is rapidly declining toward the point from which it commenced more than forty years ago.

We who devote our efforts to increase the production of food, must consider the reverses and disasters, as well as the successful enterprises, in order to intelligently point the way to a remedy. The public interest requires that the facts should be known, because the destruction of a great food producing industry is a public calamity, especially when the demand for food so much exceeds the supply that prices are more than double what they were four years ago. Should we not, therefore, consider the impending extinction of oyster production in these states, with the cause and the remedy, if it is not too late?

It appears that more than one-half of those formerly engaged in the oyster industry in these two states have abandoned this occupation and that the product is now less than one-third what it was eight years ago.

The official report of the Rhode Island Commission of Shell Fisheries for 1918 (page 45) shows that the total annual rental of oyster grounds was reduced in 1917 to $74,413. This was a decrease during five years from $135,000, being a loss of about 45%. According to a statement of Hon. Brayton A. Round, Clerk of Shell Fisheries, made in February, 1919, a still further decrease of rental occurred during the year 1918, so that the

decline in rental in six years was over $70,000 per year; and we learn from the office of Shell Fisheries that the cancellation of ground during the first nine months of the present year amounts to over $10,000, so that the business is now shrinking more rapidly than in any previous year, and the total decrease of annual rentals in less than seven years amounts to over $80,400, leaving an annual rental of $55,000, in place of $135,000 annual rental seven years ago. Mr. Round in his statement also shows that there was a shrinkage of over seventy-five per cent in the volume of product of oysters in six years. While the loss of revenue in Rhode Island alone will amount in ten years to over $800,000, this loss is of trifling importance compared with the destruction of a great food producing industry.

In Connecticut the decrease in volume of product has been in greater proportion; in fact, the development and later decline of the industry preceded that in Rhode Island. It is impossible to secure exact figures, but it is safe to say that there are not one-fifth as many oysters on the grounds in Connecticut as there were eight years ago. In Connecticut the business was successful and prosperous until eleven years ago.

How was this great industry started on its downward course?

In 1908 the Governor of Connecticut, just before the close of his administration, violated gubernatorial precedents by issuing a special message recommending the exaction of a large increase of revenue from this industry. He afterwards explained to a Committee of the Connecticut Legislature that he did this because at a banquet at which some of the officials of Rhode Island were present, he learned that Rhode Island received much more revenue per acre from her oyster grounds than did Connecticut. His superficial investigation did not extend to the primary fact that in Rhode Island the state owns the oyster grounds, whereas in Connecticut the state had sold the grounds over thirty years before and naturally should not expect as much revenue from what the state does not own as Rhode Island might expect from grounds which she owns and leases to planters. His message urged that Connecticut follow the policy of Rhode Island in exacting a heavy direct revenue on oyster grounds. That policy has proved ruinous to the industry in both states. As many of the Connecticut politicians knew that the oyster growers of

Connecticut had but few votes with which to defend their interests, some of them were ready to follow the lead of a Governor whose policy might be good politics but was not good statesmanship, and for the past ten years, the assessments on oyster grounds in Connecticut have been made, in many cases, at five and ten times their market value, although the fair market value is all that is sanctioned by the law.

During the same period chemical manufacturing wastes have been discharged into the waters of the state in greatly increased quantity, with the result that the embryo oysters have been destroyed, together with swimming fish, in vast quantities, so that the set of embryo oysters for several successive years has been practically a failure.

Under such unfavorable conditions, public policy dictated that the industrial wastes should have been kept out of the waters, and that a great food producing industry should have been fostered and encouraged. Instead of such an enlightened and intelligent policy, this time was chosen to unjustly and unlawfully exact from the oyster farmers a great amount of direct revenue, thus "killing the goose that laid the golden eggs."

Rhode Island followed the same short-sighted policy by increasing her revenue per acre from oyster grounds. It was proposed, several years ago, to add a tax amounting to thirty or forty per cent of the rentals to the revenue from oyster grounds. The writer pointed out to the Tax Commissioner of Rhode Island that the industry was already carrying "more than the traffic would bear" and that if any considerable increase was enacted, the industry would decline so that the state would receive less annually at the end of five years than it would if no increases were made. In view of the facts which the writer presented to the Tax Commissioner at that time, the proposed increase was reduced from thirty or forty per cent, as at first planned, to ten per cent, but even that proved too much, and instead of increasing the revenue, it is now less than one-half what it was when the increase of rate was enacted. The prediction of the writer was thus more than fulfilled.

The same difficulty exists also in Rhode Island as in Connecticut by reason of the discharge of industrial waste into the waters of the state, and the failure of the state authorities to police and

protect the oyster grounds so that oyster propagators, who expend many hundred of thousands of dollars yearly in propagating or planting oysters, lose much of the fruits of their labor through depredations of a class who do not expend anything to produce shell fish or any other crop, but depend for their livelihood upon catching the natural products of the waters, supplemented by what they can secure by trespass upon the thickly planted grounds of oyster planters. Production cannot continue where depredation is not suppressed.

In 1916 the writer presented a paper to this Society in which he pointed out the result which must follow such a policy as was then being pursued by the states of Connecticut and Rhode Island. At that time, oyster grounds, to the extent of thousands of acres, were being abandoned because they were being assessed at five to ten times what they would bring in the market. In that paper it was shown that oyster grounds that were assessed at five thousand dollars were publicly offered for sale for $500 and even $250.

The oyster farmers were thus wrongfully deprived of many thousands of acres of land under forms of law, but which were really confiscation. The owners were forced to give up their lands rather than to pay the taxes that were exacted. These lands had been bought for cash from the state, and taxes paid upon them for thirty years, but they were practically confiscated by the state.

The same official who in 1908 assessed a piece of ground at between eight and nine thousand dollars, assessed it in 1914 for $128,938, more than fourteen times what he had assessed it at in 1908. The rule of assessment, according to law, on both of these dates was the "fair market value," and it was worth much less in 1914 than in 1908. This is only one illustration of many hundreds in which oppressive injustice was inflicted upon the oyster farmers. Not only was the law violated with reference to assessments, but the rate of taxation was doubled, so that it is now twenty mills on the dollar of valuation, and oyster grounds three miles from land, that can enjoy none of the protection or benefits of city government, are required to pay more than real estate in the centre of a populous city!

The oyster growers were unjustly deprived of the police which they paid for by special tax, and were compelled to go to each legislature and refute misrepresentations intended to procure additional legislation against them. They were persecuted by short-sighted politicians, so that a large number of those formerly engaged in the business have abandoned it entirely, others have sold out their interests and many of the leading firms have removed their business partly or wholly from the state, and their capital is being transferred to other lines of investment.

Farmers on land are encouraged and assisted by federal and state appropriations of many millions of dollars annually. Swimming fish are propagated for the benefit of the fisherman and the angler, at great expense, by both state and federal governments. Is it then public policy to make impossible the work of the oyster farmer, who at great labor and expense produces his own crops without assistance, and pays a large revenue besides?

The writer believes that public policy requires that steps should be taken to revive the oyster industry in these states before it becomes practically extinct, and that the influence of the members of this Society will be exerted in this direction. The oyster farmers no longer expect or ask for prosperity, but public policy requires that this industry should at least be allowed to continue to exist and to produce food, of which the nation and the world are so much in need.

THE NECESSITY OF STATE LEGISLATION IN THE CONSERVATION OF FRESH-WATER MUSSELS.

By A. F. Shira,

U. S. Fisheries Biological Station, Fairport, Iowa.

In an attempt to adequately preserve the very valuable fresh-water mussel resources of our streams the two expedients, usually resorted to in such cases, have been advocated and to a certain extent practiced: (1) artificial propagation and planting, and (2) protection by legislative enactment. All of you are, no doubt, somewhat familiar with the work of artificial mussel propagation carried on by the United States Bureau of Fisheries, through its Biological Station at Fairport, Iowa. The successful results of this work are apparent, and experiments in the rearing of mussels under control to a sufficient size for making definite plants on particular bottom areas, have been successfully carried out on a small scale, and give promise of far-reaching results. Yet it must be stated that the main dependence for a continued supply of mussels must be placed upon sufficient and wise protecting laws, which can be furnished only by the states concerned.

The protection of mussels is not a new subject and its need has been repeatedly emphasized. (Coker, 1914 and 1916). (Smith, 1919).* My object in the present paper is to detail what the states have already done in making the necessary provisions and to outline what still remains to be done.

The first move for protective measures resulted in a conference at Madison, Wis., in 1914, participated in by representatives of the Bureau of Fisheries, state officials from Wisconsin, Minnesota, Illinois and Iowa, and other interested persons. At this conference a bill was drawn up and endorsed, the principal features of which provided for a size limit on the mussels, a limitation on the manner and means of capture, a license fee for resident and

* "The Protection of Fresh-Water Mussels," by R. E. Coker. U. S. Bureau of Fisheries Document No. 793. 1914.

"The Utilization and Preservation of Fresh-Water Mussels," by R. E. Coker. Trans. Am. Fish. Soc. December, 1916.

"Fresh-Water Mussels: A Valuable National Resource Without Sufficient Protection," by Hugh M. Smith. U. S. Bureau of Fisheries, Economic Circular No. 43, 1919.

non-resident clammers and, what is most important, a provision permitting the state to close certain portions of its waters to commercial clamming for a period of years to permit natural recuperation and artificial replenishment of the beds. This bill also provided for reciprocal action between states with reference to boundary waters.

This measure was immediately enacted by Minnesota and in a modified condition, by Illinois. During the past year the measure has been favorably acted upon by Wisconsin and Iowa, so there are now four Mississippi River states with quite uniform mussel laws in all essential features. These states are to be congratulated on their far-sighted policy and their praiseworthy action should lead to closer co-operation in the future, and should be a stimulus to other states confronted with the same problems.

Adequate and early action in the protection of mussels is most urgent and necessary because of the peculiar conditions involved. Owing to their rather sedentary habits they are subjected to capture to an unusual degree. A stream may become so depleted that it will no longer support a regular fishery and the last professional sheller may leave it for more productive fields. Instead, however, of being left to recuperate, the remaining mussels are subjected to haphazard and sporadic methods of fishery by persons in various walks of life until they are reduced to the last degree of exhaustion. During times of very low water, persons gather the mussels wantonly, or in search for pearls, discarding the shells. These small quantities of shells mean that in the aggregate a large amount of valuable raw material is unused and wasted. Not only this, it means the removal of nearly the last remnant of mussel life for procreation. A suitable license fee and proper law enforcement will largely do away with such practices and shelling will only take place when it can be conducted profitably from a commercial standpoint. The effect of this has been shown in the states where the protective provision has been in force.

As stated above, one of the most important measures for the conservation of mussel life is that feature which makes provision for the closing of streams or sections of streams to clamming for a period of years. The fresh-water mussel is a comparatively slow growing animal and the extensive mussel beds that once

flourished in our streams and lakes were not established in a short period of time. Consequently it cannot be expected that the resources can be perpetuated by artificial propagation and half-way methods of protection. While the Bureau of Fisheries is at present carrying on the propagation work over a large territory, the protection is in itself purely a function of the individual states. Concerted action between the states is necessary for the best interests of all. The Bureau has and is at present carrying on its work where the beds are being worked and reworked by clammers. As a result the young mussels are subjected not only to the naturally destructive agencies, but also to the injuries imposed by the implements of capture.

The provision for closing certain waters to commercial shelling makes it possible to conduct the work of artificial planting under most propitious and favorable conditions, and to note to a certain extent the results that are being obtained.

The practical application of this closing feature may be illustrated by the work that is being done in Minnesota waters. Lake Pokegama, in Pine County, Minnesota, supported a good mussel fishery up to a few years ago, when the beds were brought to a condition bordering on depletion. During this fishery probably more and finer pearls were taken from this lake, for its size, than from any other body of water in the country. On this evidence of depletion the Minnesota Game and Fish Commission closed the lake to commercial fishing for a period of four years and, since this closing, the Bureau of Fisheries has carried on the artificial propagation of mussels, and I may say in this connection that there is evidence that the mussels are on the increase as a result.

As a further evidence of the value of the protective measure and its practical working, the Minnesota and Wisconsin Commissions are going to confer relative to closing certain portions of the Mississippi River bordering on the two states. Such a conference is also going to take place between the Commissions of Illinois and Iowa.

Further, in line with the above, the state of Iowa is preparing to close certain of its interior streams, such as the Iowa, Cedar and Des Moines Rivers, to commercial shelling for a period of

years, the details of the closing to be based primarily upon information obtained by the Bureau of Fisheries for the purpose.

With the action of these states as a guide, it is hoped and confidently expected that other states such as Missouri, Arkansas, Ohio, Indiana, Kentucky, Louisiana, etc., which are so vitally concerned with the preservation of mussels, will take a corresponding interest and action.

The whole-hearted and co-operative action of the four states above mentioned with reference to the preservation of mussels presages a different policy in dealing with our natural resources in the future. What has been and is being done for the mussels can be made applicable to fishes as well. Concerted and uniform action, when possible, should be the rule. Once problems are thoroughly threshed out, obstacles to uniform action, that once seemed to be insurmountable, slowly fade away.

Efforts of the Bureau of Fisheries to develop interest in the conservation of mussels have met a cordial response from state officials, button manufacturers and commercial shellers, when they have once realized the seriousness of conditions and the consequent loss to the country.

EDITORIAL.

Prizes for Special Contributions. For the past two years the Society has offered prizes for contributions of special merit. At the last annual meeting a prize of $100 was awarded to Mr. Lewis Radcliffe, of the United States Bureau of Fisheries, for his paper on "Fishery Products Laboratories Afford the Greatest Promise of Relief of Unsolved Problems Affecting Commercial Fisheries." Mr. Radcliffe's paper appears as the leading article in this number of the TRANSACTIONS.

It is the intention of the Society to continue the offer of prizes for the present year under three heads, as formerly:

1. For the contribution showing the greatest advance in practical fish cultural work.
2. For the best contribution to biological work connected with fish problems in general.
3. For that which offers the greatest promise of the solution of problems affecting commercial fisheries work.

It is expressly stipulated that the papers offered in competition for prizes shall be in the hands of the Secretary at least one month in advance of the date of the annual meeting of the Society, in order that the Committee on Awards may have time for careful consideration of the papers. This means that such contributions in 1920 should be submitted before August 20th.

Papers previously published, or those intended for publication elsewhere than in the TRANSACTIONS are not admitted to competition and the Society reserves the right to reject all the papers in any class if none of them is considered of sufficient importance to merit the award.

Changes in the By-Laws. The most important of these provide for two new classes of members.

1. Any sporting or fishing club, or society, firm or corporation, upon the payment of an annual fee of five dollars, may become a member of the Society and entitled to all its publications.
2. Any state board or commission, upon the payment of an annual fee of ten dollars, may become a member of this Society and entitled to all its publications.

The first of these By-Laws makes it possible for fishing clubs, or for firms dealing in fish or in fishermen's and angler's supplies, to contribute to the support of this Society which, for the past fifty years, has taken a leading part in furthering the sport of the angler and the production and propagation of fish upon which the industries of many dealers and manufacturers are based.

It is hoped that many such clubs and firms may see fit to give their financial support to this Society which has contributed so greatly to their pleasure or welfare.

As the various state commissions have profited in many ways by the work of the Society, an opportunity is offered for such as are in a position to do so, to contribute financial aid.

Executive Secretary. A further change in the By-Laws abolishes the offices of Corresponding Secretary and Editor and combines the duties of these offices with certain others in the office of Executive Secretary.

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WdeGR MAY 22 1920
Division of Fishes,
U. S. National Museum

Vol. XLIX No. 2

TRANSACTIONS
OF THE
AMERICAN FISHERIES SOCIETY

Smithsonian

MARCH, 1920

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at Columbus, Ohio

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The American Fisheries Society

Organized 1870 Incorporated 1910

Officers for 1919-1920

President.....Carlos Avery, St. Paul, Minn.
Vice-President.....Nathan R. Buller, Harrisburg, Pa.
Executive Secretary.....Ramond C. Osburn, Columbus, Ohio
Recording Secretary.....John P. Woods, St. Louis, Mo.
Treasurer.....A. L. Millett, Gloucester, Mass.

Vice-Presidents of Divisions

Fish Culture.....James Nevin, Madison, Wis.
Aquatic Biology and Physics.....Henry B. Ward, Urbana, Ill.
Commercial Fishing.....J. Asakiah Williams, Tallahassee, Fla.
Angling.....John M. Crampton, New Haven, Conn.
Protection and Legislation.....J. G. Needham, Ithaca, N. Y.

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W. A. Found.....Ottawa, Canada
W. E. Barber.....Lacrosse, Wis.
W. H. Killian.....Baltimore, Md.
Geo. H. Graham.....Springfield, Mass.
Dwight Lydell.....Comstock Park, Mich.
L. H. Darwin.....Seattle, Wash.

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E. T. D. Chambers.....Quebec, Canada
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Publication Committee

Raymond C. Osburn Bashford Dean John T. Nichols

TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

VOLUME XLIX NUMBER 2

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Edited by Raymond C. Osburn

MARCH, 1920

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COLUMBUS, OHIO

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PROCEEDINGS

of the

American Fisheries Society

Forty-Ninth Annual Meeting

Louisville, Ky., October 8th, 9th and 10th, 1919

Headquarters, Seelbach Hotel

Opening Session, Wednesday Morning, October 8th, 1919.

The meeting was called to order by the President, Hon. M. L. Alexander, Conservation Commissioner of Louisiana.

Hon. Edward J. McDermott, formerly Lieutenant-Governor of Kentucky, was then introduced and welcomed the Society to Louisville and Kentucky in a pleasing address.

Hon. W. H. Killian, Conservation Commissioner of Maryland, was called upon to respond to the address of welcome.

A short business meeting followed.

Owing to the defection of the stenographer who took the report of the earlier sessions, the exact record of the proceedings with all of the discussion, has been lost, up to the afternoon session of October 9th. Fortunately, certain matters were preserved in the hands of the officers of the Society and among these were the reports of the Treasurer and Corresponding Secretary, the list of new members elected, etc.

REPORT OF THE TREASURER.

GLOUCESTER, MASS., Sept. 27, 1919.

To the American Fisheries Society:

I herewith submit my annual report as Treasurer from the meeting in September, 1918, to the 27th of September, 1919.

RECEIPTS.

Balance in Treasury		$142.59
Annual dues:		
For year 1912	$ 2.00	
For year 1913		
For year 1914	8.00	
For year 1915	18.00	
For year 1916	36.00	
For year 1917	48.00	
For year 1918	602.00	
For year 1919	36.00	
For year 1920	6.00	
		$756.00
Sales of Transactions		280.73
Collection on checks, etc		.19
		$1,179.51

DISBURSEMENTS.

Waldorf-Astoria, rent of typewriter; phone	$ 6.50	
Elite Letter Co., multigraphing	4.00	
Bastian Bros., celluloid buttons	25.04	
J. C. Hall Co., book of receipts	8.00	
J. J. Farrell, clerical services	25.00	
J. B. Lyon Co., circulars, envelopes	27.50	
Gloucester National Bank, adjusting uncollectible check	4.00	
Waldorf-Astoria	.80	
Gloucester National Bank, adjusting account	2.00	
Thorpe & Martin Co., letter file	1.40	
Postage (Treasurer)	18.80	
Postage and insurance on Transactions sold	.28	
Postage (Corresponding Secretary)	1.34	
Bucher Engraving Co., work for Transactions	1.00	
Postage (Editor)	6.00	
Postage (Treasurer)	13.50	
Allen Bros., rubber stamp	.50	
Wright & Potter Pr. Co., letter heads	6.25	
Rexford L. Holmes, reporting 1918 meeting	190.92	
M. Riddell, multigraphing	3.57	
Bucher Engraving Co., work for Transactions	11.98	
Postage and envelopes (Corresponding Secretary)	4.04	
L. B. Rimbach, clerical services	100.00	
Goodwin Bros. Printing Co., circulars, app'ns., etc	39.25	
Goodwin Bros. Printing Co., circulars	12.50	
Goodwin Bros. Printing Co., letter heads	8.50	
John P. Woods, stenographic expenses, stamps, envelopes, express, etc	22.57	
		$ 545.24
Balance, per Cash Book		$ 634.27

PERMANENT FUND OF THE SOCIETY.

Balance as reported at 1918 meeting	$2,995.96
Interest, February 1st–Aug. 1st, 1918	59.90
	$3,055.86
Disbursement, C. G. Embody, prize paper	100.00
Balance	$2,955.86

(Signed) ARTHUR L. MILLETT,
Treasurer.

Referred to the Auditing Committee.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary, having in his possession a large stock of TRANSACTIONS of the Society, undertook the disposal of several sets to university and public libraries.

TRANSACTIONS were sold to the following named institutions, for the amounts set opposite their names:

Harvard College Library	$10.50
Ohio State University Library	12.25
Rutgers College Library	32.00
Yale University Library	33.50
Leland Stanford Junior University	16.50
University of the State of New York	9.50
Academy of Natural Sciences	33.50
Museum of Natural History (New York)	.50
New York Public Library	10.50
Canadian Biological Stations:	
St. Andrews	33.50
Nanaimo	33.50
Public Library, City of Boston	29.00
	$254.75

The total amount resulting from these sales, $254.75, has already been deposited with the Treasurer, Mr. Arthur L. Millett.

Respectfully submitted,

C. H. TOWNSEND,
Corresponding Secretary.

Dated, New York, October 16, 1919.

Approved by action of the Society, with thanks to Dr. Townsend for his active and practical interest in the welfare of the Society.

NEW MEMBERS.

A complete list of those elected during the meeting is appended to the membership list as published in the September number of the TRANSACTIONS.

REPORT OF THE COMMITTEE ON UNIVERSITY COURSES IN FISH CULTURE.

The American Fisheries Society as assembled in New York City, September, 1918, passed the following resolution:

WHEREAS, the conditions of the present have shown the need of developing the food resources of the country to meet the demands not only at the present moment, but also in the future, and

WHEREAS, the opportunities for securing specific training in the principles of fish culture are extremely limited, if not entirely lacking in the educational institutions of the country, and

WHEREAS, such training is important not only in the service of the state and nation, but also to the individual land owner, who can advantageously engage in fish production on a small scale in connection with his agricultural activities; therefore, be it

Resolved, that the American Fisheries Society recommend the establishment of courses in fish culture, which will open a new field of activity for many who find themselves adapted to such work and at the same time furnish a force of trained workers to meet the demand of state and nation.

That this may be achieved in most effective fashion, the President of the Society is hereby directed to appoint a committee of five to consider the plan of procedure which shall best attain the desired end.

This committee as appointed by President M. L. Alexander, consists of: Professor G. C. Embody, Chairman, Cornell University, Ithaca, N. Y.; Dr. R. C. Coker, U. S. Bureau of Fisheries, Washington, D. C.; John W. Titcomb, Conservation Commission, Albany, N. Y.; Professor Raymond C. Osburn, Ohio State University, Columbus, Ohio; Prof. Jacob Reighard, University of Michigan, Ann Arbor, Mich.

In the above resolution this Society recommends the establishment of courses in fish culture in the educational institutions of the country. The duties of this committee are then to suggest a plan of procedure which shall best attain the desired end.

After due consideration of the matters involved, the following report is offered:

I. *Full Term Courses in Fish Culture.*

It is the consensus of opinion that a well equipped university, by a properly selected course of study, may give everything necessary for the student of fish culture except the practical work. Therefore, at least four different classes of students may be partly or wholly provided for, namely, those who would become (1) Practical Fish Culturists, (2) Teachers of Fish Culture, (3) General Investigators of Fish Cultural Problems and (4) Fish Pathologists.

All universities now offer courses in the fundamental subjects, such as general biology, zoology, botany, physics, chemistry, etc. In addition to these the committee suggests the following as being essential to the proper training of students for the four classes of work enumerated. The subjects considered most important are placed early in the lists.

A. For Practical Fish Culturists.

Ichthyology.
Limnology (aquatic zoology and botany).
Principles of Fish Culture.
Practice in Fish Culture.
The Hydrology and Mechanics of Fish Cultural Problems.
Animal Physiology.
Principles of Nutrition.
Genetics and Principles of Breeding.

B. Teachers of Fish Culture.

The subjects should be the same as for Practical Fish Culturist, but the amount of practical work required may be advantageously diminished.

C. For General Investigator.

Ichthyology.
Limnology (aquatic zoology and botany).
Principles of Fish Culture.
Practice in Fish Culture.
Hydrology and Mechanics of Fish Cultural Problems.
Parasitology.
Animal Physiology.
Biochemistry.
Principles of Nutrition.
Embryology.
Bacteriology (General and Pathogenic).
Genetics.

D. For Fish Pathologist.

Ichthyology.
Limnology.
Principles of Fish Culture.
Bacteriology.
Parasitology.
Histology.
Pathology.
Fish Diseases.
Animal Physiology.
Biochemistry.
Principles of Nutrition.
Embryology.
Genetics.

In addition to the courses outlined under C and D, research in some special line should always be considered essential.

II. Short Courses.

Certain agricultural colleges now offer short courses for students unable to devote a full year to study. The entrance requirements are usually low, or entirely lacking, and the type of student is often below the average educationally. Nevertheless, these short courses are working towards better agriculture and, in the opinion of the committee, similar courses in fish culture would raise the standard of fish culturists and at the same time make the younger men more quickly available.

It is therefore recommended that short courses in the following subjects be given in those universities now offering short courses in agriculture.

Subjects for a Twelve Weeks' Course in Fish Culture.

Principles of Fish Culture.
Fish Life.
Forage Organisms.
Fish Feeding.
Fish Breeding.
Fish Diseases.

III. Practical Work in Fish Culture.

There are probably few universities so situated as to be able to maintain plants for fish production large enough to give the student the necessary practical work. It will therefore be necessary for state, national and private commercial hatcheries to co-operate with the universities to the extent of furnishing employment to students for a part of the year at least.

A parallel case is to be found in the agricultural college requiring a certain amount of practical work for graduation. Here students are often employed on private farms during the vacation period. It ought not to be difficult to make similar arrangements between universities and those operating hatcheries for the latter to employ worthy students of fish culture.

Wherever it is possible for a university to maintain a plant for fish production, this is to be strongly recommended because of the many advantages to be derived from the close contact of student with the actual work of the hatchery and because of the opportunities here offered for specialists to engage in the study of the many unsolved problems of fish culture.

IV. *Financial Aid.*

The training of men to engage in practical fish culture and the investigation of fish cultural problems cannot be done without adequate financial support. Especially is this true of the latter, in which case special and expensive laboratory apparatus is essential to success and in which the results are obtained only after careful and prolonged research.

It is most urgent that more work be done upon the problems of fish diseases, fish forage, selective breeding of fishes, pollution and others which vitally affect successful fish culture. However, we must not expect that these can be satisfactorily solved without financial assistance.

We are forced to believe that one of the greatest reasons why progress in fish culture has not been as rapid as in many other branches of husbandry, is a lack of financial support. For these reasons we strongly recommend:

First. That state and national governments, and persons who may wish to advance the worthy cause of fish culture, render financial aid to those universities disposed to offer the courses outlined in this report.

Second. That so-called "industrial fellowships" in subjects relating to fish culture be established in institutions possessing facilities for research to the end that properly qualified investigators may be encouraged to work on the problems most vitally and immediately affecting the interests of fish culture.

Respectfully submitted,

G. C. Embody, *Chairman*,
R. C. Coker,
John W. Titcomb,
Raymond C. Osburn,
Jacob Reighard,
Committee.

(This report was approved by vote of the Society. Unfortunately the discussion of the matter has been lost through the fault of the stenographer.)

APPOINTMENT OF COMMITTEES.

President Alexander appointed the following committees to serve during the meeting:

Committee on Nominations: Messrs. Geo. H. Graham, E. W. Cobb, Dwight Lydell, John M. Crampton, S. W. Downing.

Resolutions Committee: Messrs W. H. Killian, A. L. Millett, L. H. Darwin, W. D. Barber, Linus Leavens, E. A. Tulian, W. D. Howser.

Committee on Time and Place of Meeting: Messrs. James Nevin, G. N. Mannfeld, John H. Wallace, Jr., Alva Clapp, Richard Porter.

Committee on Awards: Messrs. John W. Titcomb, A. L. Millett, Carlos Avery, Raymond C. Osburn, J. A. Williams.

Program Committee: Messrs. Raymond C. Osburn, John P. Woods.

Auditing Committee: Messrs. M. D. Hart, C. F. Culler, C. O. Hayford.

Committee on Membership: Messrs. E. A. Tulian, E. W. Cobb.

Wednesday Afternoon Session, October 8th, 1919.

The entire afternoon was spent on an automobile drive as the guests of the Kentucky Game and Fish Commission. During the course of the trip, various sections of the city were visited, as well as the United States Fish Hatchery, where an hour or so was spent in the inspection of the Pumping Station, the Breeding and Rearing Ponds, etc.

The drive then led through Iroquois Park, where splendid views of the city and surroundings were obtained on a high hill; thence to Camp Taylor, and finishing with a drive of several miles along the Ohio River.

Wednesday Evening Session, October 8th, 1919.

A very enjoyable banquet was tendered the members and lady guests of the Society by the Kentucky Game and Fish Commission in the rooms of the Pendennis Club.

Following a thoroughly good dinner, the toastmaster, Mr. John P. Woods, called upon various members, among them, President Alexander and Messrs Carlos Avery, John H. Wallace, Jr., Raymond C. Osburn, J. Q. Ward, E. E. Prince, J. A. Williams, Gro. H. Graham and W. H. Killian.

Thursday Morning Session, October 9th, 1919.

READING OF PAPERS.

Water Pollution.

A paper prepared by the Massachusetts Fish and Game Commission and presented by Mr. David L. Belding, Biologist of the Commission.

Mr. Belding stated what has been accomplished in Massachusetts and outlined the work to be attempted in the near future. The plans contain a thorough educational program on pollution and its effects to acquaint the people of the state with this abuse of public waters.

Report on the Shad Situation.

By Mr. G. C. Leach, U. S. Bureau of Fisheries. Extensive propagation was advocated as the only means of preventing the extinction of the shad as a commercial fish and of restoring it to its proper importance in our food supply.

After extended discussion, it was moved and carried that a special committee be appointed, consisting of representatives of coastal states and provinces and of the commercial interests, to whom this matter should be referred for consideration.

Thursday Afternoon Session, October 9th, 1919.

COMMITTEE ON TIME AND PLACE OF MEETING.

The Committee presented a report favoring Ottawa, Canada, as the next meeting place, and the date as September 20, 21 and 22, 1920.

On motion, duly seconded, the report of the Committee was approved by vote of the Society.

READING OF PAPERS.

A Plea for a Systematic Study of Fish Diseases.

By W. M. Keil, Tuxedo Park, N. Y.

Mr. Keil requested that one day be devoted entirely to the discussion of fish diseases and parasites, at some meeting of the Society in the near future.

The request embodied in the paper was referred to the Executive Committee.

The Chesapeake Bay.

By Talbot Denmead,
Chief Deputy Warden of Maryland.

This paper appears in this number of the Transactions.

The Prime Essential in Commercial Fish Conservation.

By Wm. K. Mollan,
President of the Connecticut State Board of Fisheries and Game.

This paper, with the discussion which followed, appears in this number of the Transactions.

Changing Food Conditions of the Trout Family.

By James Nevin,
Division of Fisheries, Wisconsin Conservation Commission.
(See Transactions for December, 1919, Vol. XLIX, No. 1, pp. 29-32).

The Blackspot Disease of the Bullhead or Hornpout.

By Prof. Raymond C. Osburn,
Ohio State University, Columbus, Ohio.

Dr. Osburn also presented photographs illustrating the disease, together with bottled specimens of the blackspot tumors.

Why Do Salmon Ascend From the Sea?

By Prof. Edward E. Prince,
Dominion Commissioner of Fisheries, Ottawa, Canada.

This paper, with discussion, will appear later in the Transactions.

REPORT OF THE AUDITING COMMITTEE.

The auditing Committee has examined the statements, vouchers and books of Mr. Arthur L. Millett, Treasurer, and find them correct.

(Signed) M. D. Hart, *Chairman*,
C. O. Hayford,
C. F. Culler.

The report was approved.

The Society adjourned to meet at 8:00 o'clock, P. M.

Thursday Evening Session, October 9th, 1919.

READING OF PAPERS.

The Growth of Fishes.

By Dr. A. G. Huntsman,
Toronto University, and head of the Atlantic Biological Station of Canada, at St. Andrews, N. B.

In the absence of Dr. Huntsman, this paper was read by Prof. Edward E. Prince. This paper has already been printed, with the discussion which followed, in the Transactions for December, 1919, p. 19-23.

Fresh Water Mussels as a Fish Food.

By Dwight Lydell,
Comstock Park, Mich., Superintendent of the Hatchery.

This paper was read by Mr. John W. Titcomb, and has already appeared in the Transactions for December, 1919, pp. 24-28, together with the discussion.

The Preservation of the Alewife.

By David L. Belding,
Biologist to the Massachusetts Fish and Game Commission.

Mr. Belding's paper, with the discussion, appears in this number of the Transactions.

The Society adjourned, to meet at 9:00 o'clock, Friday morning.

Friday Morning Session, October 10th, 1919.

READING OF PAPERS.

Beneficial Results of the Introduction of Plant Life in Trout Ponds at the New Jersey State Fish Hatchery.

Charles O. Hayford,
Superintendent of the Hatchery, Hackettstown, N. J.

This paper was read by Prof. J. G. Needham, of Cornell University. See this number of the Transactions.

Louisiana, Greatest in the Production of Shrimp (Penaeus setiferus).

By E. A. Tulian,
Superintendent of Fisheries, Department of Conservation of Louisiana.

To appear, with the discussion, in a later number of the Transactions.

BUSINESS.

President Alexander: Gentlemen, before proceeding further, there is a question that the Nominating Committee would like to be advised upon before submitting their final report. That is the question of the position of the Recording Secretary, Corresponding Secretary and Editor.

(Dr. Prince was asked to preside temporarily.)

President Alexander, continuing: I recommend to the Society that we have a permanent officer of some sort, who should be compensated for his services. He could devote the amount of time necessary to compiling the records of this Society and to keeping them in proper form, and to giving us a degree of publicity which would be a benefit to the Society. This obligation should fall either upon the Secretary or upon the Editor, who has represented this Society for a long period of years and who has devoted a large amount of his time to that work unselfishly and patriotically, we might say, in the interests of the Society. But the burden has become rather heavy upon him and it would be necessary to give more consideration should he take the position of Corresponding Secretary as well as that of Editor. It is a matter that I think should be discussed by the Society as a whole,

so that our Nominating Committee, in its further deliberations, may decide as to the officers best qualified to fill these positions.

(Mr. Alexander here resumed the chair).

Mr. Geo. H. Graham, of Massachusetts: If we are going to have this work carried on carefully and systematically we must have somebody do the work who will be satisfied with the compensation received. We have been coming to these meetings year after year, enjoying ourselves, paying our two dollars and going away. But we are asking one of our members to look after the work all through the year, and to give a large part of his time without any compensation, which is not really a fair proposition.

I will admit that up to this year we have not been in a position to do much financially, because we have been in debt. The first thing we must do is to arrange for more revenues and the question is, how are we going to do it? It seems to me that there are a great many sources of revenue we can logically call upon. In the first place, I believe every state should take out a state membership, similar to the one taken out by the State Commissioners in the International Association of Game and Fish Commissioners. There each state pays $25 as its state membership. You can readily see that $25, if all the states join, makes a thousand dollars to start with.

Now, the work that is being done by this association is beneficial to all the manufacturers and dealers in the United States and Canada who are making or handling lines, fish hooks, rods, reels, canoes, motorboats, and everything of that kind. Why should we not have a membership that would take care of these men. When they realize the actual benefit which they are receiving from the work of this organization, they should not hesitate in taking a membership. It seems to me it is a very simple matter to get a few hundred of these memberships at at least $5.00 per member.

There is another live source of revenue in the libraries. Every live library in the United States should be a member of this association and pay at least $2.00 a year, if not $5.00. My plan is this: Select a man for Secretary and tell him that for the first year we will give him $300 as his salary, with all legitimate expenses. At the end of the year we will see what he has done

and if we find we can pay him $500, let us pay him $500; if we find we can pay him $1,000, let us pay him $1,000. What difference does it make how much salary he gets so long as he gets in the money. If you will put it on that ground, you will get a man to put his time to it. There is no man in this room who will give his time to this thing for nothing. Why not make it attractive to somebody?

You all know that when these reports are sent out, every statement made by each member must be carefully edited. If you make an extemporaneous speech, it doesn't sound just as you would like to have it, perhaps, when it gets into print. The members here understand what you are trying to say, but in print it doesn't look well. We should each have a chance to correct what we say, before it goes into print. It takes a good deal of time to sort out the different sections and send them to the various speakers. Some of them negligently fail to return the corrected copy promptly as requested; some even wait two or three months before sending in their corrections.

Someone has to be patient and be on the job all the time. I would like to make a motion that some such plan as that outlined be put into effect and that we arrange to combine the two offices of the Corresponding Secretary and the Editor, and pay the incumbent $300.00 for next year.

Mr. W. H. Killian, of Maryland: I would like to second the motion and to say something in support of it. This is the Forty-Ninth Annual Meeting of the American Fisheries Society. Those of us who have been attending meetings for a sufficient length of time to see the scope of its work, know its possibilities are very great.

I do not like the name of Corresponding Secretary or Editor for a position of this kind. I think there is more force in a title like Executive Secretary or Business Manager. We understand the principles set forth by Mr. Graham for gathering sufficient revenue to continue this work as it should be continued, and not only to increase the revenue, but by reason of that activity to spread the influence of this Society by increasing the membership. The members would be more interested and would attend in larger numbers than has been the case in the past. I know from

experience that when you get the kindred trades interested in a society, as associate members, they always attend the meetings because they meet the people who are helpful to them in their business and they do a larger amount of advertising to the Society throughout the year. I wish heartily to endorse that idea and to second it.

Mr. A. L. Millett, of Massachusetts: It seems to me, before we go into the discussion, that we should hear from the man who has been our Editor for many years. I refer to Dr. Osburn.

Dr. R. C. Osburn: I did not mean to discuss this matter at all. I came here expecting to resign from office because I felt that, with the duties necessary to my university, I could not afford the time. I have given my time in the past because I felt it was my duty to the Society to do so. I fully intended to resign last year. I went to New York and found so many of our men engaged in war work of various kinds that I said to myself, "I will serve another year, anyway, and will make it my contribution to furthering the work of our fisheries."

Gentlemen, we must have more money if we are going to publish as we should. We are out of debt, to be sure, and have produced, I think, a very creditable journal. Our publishing bill for the past year will be approximately $700. If we are to publish all the valuable papers presented at this meeting the bill will be considerably more. I had to reject a number of papers last year for lack of funds. We will just about come out even this year after the bills are paid. We must have, then, more funds in order to carry on this work properly.

As to the name of the proposed office, if I may make a suggestion, the term "Permanent Secretary" rather appeals to me. It is used by other societies, such as the American Association for the Advancement of Science, the largest scientific body in our country and one of the most thriving.

I am not financially interested in the matter, for the amount of the salary suggested I consider merely an honorarium. You could not hire me to do it for anything like that amount. In the past years I have accepted the burden because of my interest in the work.

Secretary Woods: May I suggest that we do away with the name "Recording Secretary." In New York, at the solicitation of your Nominating Committee, I was induced to accept that position for one year. I am able to state, as my excuse, that I had an interest in the Society in that I had an opportunity to do in it very much good work. Now, there should be no delicacy about doing away with the office of Recording Secretary in order to have a Permanent Secretary, and if, by chance, you have in any manner considered me personally in the matter as an officer, I suggest that you overlook that entirely.

President Alexander: Gentlemen, I want to have publicly expressed my great appreciation of the very thorough and painstaking service of the Recording Secretary, Mr. Woods, during the past year. His services have been invaluable to the Society.

Mr. Graham's motion to combine the offices of Corresponding Secretary and Editor under some designated name and pay the officer $300.00 for the first year, being seconded, was unanimously carried.

President Alexander suggested leaving to the Nominating Committee the designation of the office.

Mr. Titcomb suggested that the Nominating Committee make provision for a Local Secretary, to attend to the secretarial work during the meeting. President Alexander spoke in approval of this suggestion.

Mr. Carlos Avery, of Minnesota: I would like to move also that the Committee be instructed to bring in a recommendation amending the by-laws as to membership dues. In order to pay this salary the money must be forthcoming, and there should be some different arrangement, as Mr. Graham suggests.

Personally, it appears to me that the regular dues might very well be raised. The value of a dollar is only about half what it used to be, and those who are paying $2.00 a year are really paying half what they used to pay. It seems to me there might be no serious objection to raising the dues to $4.00 or $5.00 a year, which would be a wonderful help in raising this additional money. The Permanent or General Secretary who may be

elected, and whose duty it will be to secure new members, can no doubt greatly increase the membership by the right sort of argument. If dues are slightly increased, it would seem that the necessary money would easily be forthcoming. I make that motion.

MR. TITCOMB: I second the motion, although I realize the larger number of men paying these dues are in reality receiving half the compensation they received before the war.

MR. GRAHAM: To me it would seem that the $2.00 membership should be left as it is, but why should we carry on this work for these thousands of other people who are not paying anything?

PRESIDENT ALEXANDER: It is Mr. Avery's recommendation that we simply recommend to the Committee that it shall bring in any report they see fit. It is moved and seconded that a recommendation of this body go to the Committee to consider an advance in dues.

(The motion was carried unanimously).

READING OF PAPERS.

A Word About Florida, Her Fish and Her Fisheries.

By J. AZAKIAH WILLIAMS,
Conservation Commissioner of Florida.

Mr. Williams' paper will appear in a later number of the TRANSACTIONS.

Plants That Are of Importance in Ponds.

By DR. EMMELINE MOORE,
Madison, Wisconsin.

This paper with discussion, will appear in a later number of the TRANSACTIONS.

Owing to lack of time, the following papers were read by title:

Chemical Composition of Salmon During the Migration Fast.

By DR. CHAS. W. GREENE,
University of Missouri.

Nitrogenous Changes, Etc., in Salmon.

By CARL L. GREENE.

Concerning the Protection of Fish, Fish Food and Inland Waters.

By Dr. Jas. A. Henshall,
Cincinnati, Ohio.

The Retail Fish Market, Some Suggestions for Equipping and Conducting it.

By Arthur Orr,
Bureau of Fisheries, Washington, D. C.

Practical Fish Culture.

By G. H. Thomson,
Estes Park, Colorado.

BUSINESS.

President Alexander: It is only half past twelve and we will continue in session until we complete the business of the Society. The Secretary has an announcement to make.

Secretary Woods: Mr. J. Q. Ward desires those who wish to go to Frankfort on Saturday morning to register here before we adjourn. I understand the object of the trip is to visit the State Hatchery.

REPORT OF COMMITTEE ON AWARDS.

Presented by Mr. John W. Titcomb, Chairman.

The contest for the prizes offered by the Society comes under three heads:

First: For the contribution showing the greatest advances in practical fish cultural work. Under this head there were two papers.

Second: For the contribution showing the best biological work applying to fish problems generally. No papers.

Third: For the contribution that best promises relief to and solving of the problems affecting commercial fisheries. Six papers.

In Group 1, the paper of Mr. Lydell entitled "Freshwater Mussels as Fish Food," is deemed by the Committee to deserve honorable mention, but it was presented too late to conform to the conditions of the award.

In Group 3, the paper which is awarded the prize is that by Mr. Louis Radcliff, "Fishery Products Laboratories Afford the Greatest Promise of Relief of Unsolved Problems Affecting Commercial Fisheries."

The paper by Mr. W. K. Mollan, the Commissioner from Connecticut, "The Prime Essential in Commercial Fish Conservation," is given honorable mention; and the paper by Mr. Arthur Orr, of the United States Bureau of Fisheries, is regarded as one treating on a very important subject, "The Retail Fish Market; Some Suggestions for Equipping and Conducting it." The committee expresses the hope that this paper can be used in some way in pamphlet form as propaganda to be sent broadcast throughout the country, in the hope that our conditions in the market may be improved.

The Committee has taken the liberty of making some recommendations, namely: (1) that the Society continue to hold these prize contests; (2) that notices of the proposed awards be sent out at least nine months in advance and also that they be published in the first number of the TRANSACTIONS; (3) that notice of intention to compete, with the subject, be submitted to the Secretary three months in advance of the annual meeting; (4) that the papers are to be submitted to the Secretary one month in advance of the annual meeting, and if possible that the papers be submitted in duplicate. It is further suggested (5) that the President name a Committee on Awards to judge the papers and that, in advance of the annual meeting, as soon as possible after the Secretary receives the competing papers, they be furnished to the chairman in order that the Committee may have ample time to go over them. The conditions provided two years ago are to stand, except for the changes here suggested.

After some discussion it was decided to eliminate the third point requiring three months notice of intention to compete, leaving as the only requirement, that the papers shall be in the hands of the Secretary one month in advance of the annual meeting.

With this change the report of the Committee on Awards was approved by vote of the Society.

REPORT OF THE COMMITTEE ON RESOLUTIONS.

Presented by the chairman, Mr. W. H. Killian, of Maryland:

(1). *Treaties With Cuba and Latin America.*

Resolved, That the President of the United States be, and he is hereby memorialized and requested to propose treaties with the Governments of Cuba and the Latin American Republics for the protection of fish which migrate between the United States and Cuba and such republics.

On motion, duly seconded, the resolution was adopted, Mr. J. A. Williams, of Florida voting in the negative.

(2). *Prevention of Water Pollution.*

WHEREAS, the Commission on Fish and Game of the State of Massachusetts has presented to this society through its biologist, Mr. David L. Belding, a paper on "Water Pollution," and

WHEREAS, said paper presents a definite plan for systematic and uniform action which may be adapted to the conditions in any state or province covered by the membership of this organization, therefore be it

Resolved, That the thanks of this Society are hereby extended to the Massachusetts Commission for their painstaking labor and their courtesy in supplying the Society with copies for distribution.

Resolved, also, that the states are hereby urged, through the Fish and Game Department of each, to take up this work at the earliest possible moment.

(Adopted unanimously).

(3). *University of Washington.*

WHEREAS, it comes to the notice of this Society that the State University of Washington has established a School of Fisheries, an undertaking which promises inestimable nation-wide benefit, and which is the fruition of long-felt hope, therefore be it

Resolved, That the American Fisheries Society extends its thanks and congratulations to the Faculty of the University of Washington and its wishes for the complete success of the enterprise.

(Adopted unanimously).

(4). *Cornell University.*

WHEREAS, Cornell University has established courses in fisheries work and game propagation, an undertaking which promises to be of very great value to the fish and game work of the whole nation, therefore, be it

Resolved, That the American Fisheries Society extends its thanks and congratulations to the Faculty of Cornell University and the hope that new courses may prove entirely successful.

(Adopted unanimously).

(5). *On the Death of Dr. Joseph Kalbfus.*

WHEREAS, Dr. Joseph Kalbfus, Secretary of the Board of Game and Fish Commissioners of Pennsylvania, and an honored member of this Society, the pioneer in this country in the establishment of state and game refuges, and a leader in securing the passage of model game and fish laws, and

Whereas, Dr. Kalbfus has departed this life since the last meeting of this Society, be it

Resolved, That in his death this Society has lost a wise leader and an able counselor, and its members a true and faithful friend; and

Resolved, That a copy of this resolution be sent to the members of the family of the deceased, together with our sincere condolences, likewise to the Pennsylvania Commissioners and to the sportsmen's papers throughout the country.

A standing vote was taken in honor of Dr. Kalbfus' memory and the resolution adopted unanimously.

(6). *The President of the United States.*

Resolved, That the American Fisheries Society deeply deplores the illness of our President, the Honorable Woodrow Wilson, and earnestly hopes that he may be speedily restored to vigorous health and active duty, and be it further

Resolved, That a copy of this resolution be sent to the Private Secretary of the President, Hon. Joseph P. Tumulty.

The resolution was adopted unanimously by a standing vote.

(7). *To Louisville, Kentucky, and the Kentucky Fish and Game Commission.*

Resolved, That the thanks of the American Fisheries Society be extended to the citizens of Kentucky and especially of Louisville, and in particular to the members of the Kentucky Fish and Game Commission, for the splendid hospitality so graciously accorded during this convention.

(Adopted unanimously).

(8). *To the Louisville Press.*

Resolved, That the thanks and appreciation of the American Fisheries Society be voted to the Press of the City of Louisville for the publicity given to the proceedings of this, the Forty-ninth Annual Convention.

(Adopted unanimously).

(9). *Extending Thanks To President Alexander.*

Resolved, That the thanks and appreciation of the Society be extended to Hon. M. L. Alexander, whose able administration during the year and dignified leadership during the convention have been of great value to the Society.

Secretary Woods assumed the chair and asked for a rising vote, which was given unanimously.

(10). *To Recording Secretary Woods.*

Resolved, That the thanks and appreciation of the Society be extended to Mr. John P. Woods, whose able, arduous labor and enthusiasm in the work of the Society have been an important factor in producing a most successful meeting.

The resolution was adopted unanimously by a rising vote.

(11). *Resolution To Extend the Three-Mile Limit.*

This resolution was drawn up by Prof. E. E. Prince, Dominion Commissioner of Fisheries for Canada. By the request of the Society, at its 1918 meeting, it was published, for fuller consideration, at the end of Dr. Prince's paper on "Territorial Waters and a Suggested Extension of the Three-mile Limit." See page 190, Transactions, American Fisheries Society, Vol. 48, No. 3, June, 1919.

Prof. Prince begged permission to withdraw or postpone action on the resolution, on the ground that certain representative men, much interested in the matter, were not present to discuss it.

Prof. Prince's request was granted and no further action taken on the resolution.

CHANGES IN THE CONSTITUTION.

The Committee on Constitution, Mr. Geo. H. Graham, Chairman, proposed the following changes:

(1) Combining the offices of Corresponding Secretary and Editor under the new office of "Executive Secretary," Article IV, paragraph 1, should be changed to read:

"The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; an executive secretary, a recording secretary, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum."

The proposed change was unanimously approved.

(2) In order to provide the means for better financial support, Article II, paragraph 2, should be changed to read: "Any sporting or fishing club, society, firm or corporation, upon two-thirds vote and the payment of an annual fee of Five Dollars, may become

a member of this Society and entitled to all its publications. Libraries shall be admitted to membership at Two Dollars a year."

Libraries were at first included in this proposed change, but after some discussion, it was decided to admit them on the old basis at Two Dollars a year. With this exception, the resolution was adopted unanimously to read as above indicated.

(3) A change providing for State Membership. "Any state board or commission may, upon the payment of an annual fee of Ten Dollars, become a member of this Society and be entitled to all of its publications," this to constitute paragraph 3 of Article II.

After some discussion in which some of the members advocated a fee of Twenty-five Dollars, the resolution was carried unanimously in the form above stated.

Mr. Graham: There seem to be no other changes necessary. The Constitution was changed last year, permitting us to take in the Shell Fish Commissioners and we have made arrangements with Mr. Killian, of Maryland, to take the matter up with that Society. In all probability, when the next meeting of their Society is held at Atlanta, next May, they will vote unanimously to come into this organization and take State Memberships. Fifteen states belong to that organization and it will give us considerable revenue.

REPORT OF THE COMMITTEE ON NOMINATIONS.

Presented by Mr. Geo. H. Graham, of Massachusetts:

The Committee begs to present for your consideration the following names for Officers of the American Fisheries Society for the year 1919-1920:

President—Carlos Avery, St. Paul, Minnesota.
Vice-President—Nathan R. Buller, Harrisburg, Pennsylvania.
Executive Secretary—Raymond C. Osburn, Columbus, Ohio.
Recording Secretary—John P. Woods, St. Louis, Missouri.
Treasurer—Arthur L. Millett, Gloucester, Massachusetts.
Executive Committee:

G. C. Leach, Chairman, Washington, D. C.
George H. Graham, Springfield, Massachusetts.
W. A. Found, Ottawa, Canada.
William E. Barber, Lacrosse, Wisconsin.
W. H. Killilan, Baltimore, Maryland.
Dwight Lydell, Comstock Park, Michigan.
L. H. Darwin, Seattle, Washington.

Vice-Presidents of Divisions:

Fish Culture—James Nevin, Madison, Wisconsin.
Aquatic Biology and Physics—Henry B. Ward, Urbana, Illinois.
Commercial Fishing—J. Asakiah Williams, Tallahassee, Florida.
Angling—John M. Crampton, New Haven, Connecticut.
Protection and Legislation—J. G. Needham, Ithaca, New York.

Committee on Foreign Relations:

George Shiras, Chairman, Washington, D. C.
H. M. Smith, Washington, D. C.
Wm. C. Adams, Boston, Massachusetts.
James White, Ottawa, Canada.
Edward E. Prince, Ottawa, Canada.

Committee on Relations with National, State and Provincial Governments:

Henry O'Malley, Chairman, Seattle, Washington.
William L. Finley, Portland, Oregon.
Jacob E. Reighard, Ann Arbor, Michigan.
E. T. D. Chambers, Quebec, Canada.
George A. Seagle, Wytheville, Virginia.

Moved and seconded that the report be adopted as a whole and that the Recording Secretary be requested to cast a single vote for the Society. The motion was unanimously carried and the above named gentlemen were declared to be elected to serve as the officers of the Society for the year 1919-1920.

Retiring President Alexander: I now have the pleasure of introducing to you our new President, Mr. Carlos Avery, of St. Paul, Minnesota. I do not know any member of the Society who is more worthy of the honor and I feel quite confident that Mr. Avery's splendid executive ability and excellent qualities in every way, will enable him to give you a most successful administration of the office.

President Avery: Fellow members of the American Fisheries Society:—I hope you will realize that I am not unmindful of the distinguished honor that you have conferred upon me. I fully realize also the responsibilities that go with the position.

The American Fisheries Society is distinctly a scientific society, because of the investigations carried on by the scientific men who belong to it. From these investigations come the really solid

results. You are aware, of course, that I am not a scientific man. My experience has been wholly in an administrative capacity and if I have any capability at all it is in that direction, and, in the coming year, I must lean upon those who are more experienced and more competent in the real work of the Society.

The year before us is the semi-centennial year of the Society and I believe that if we have the full co-operation of all the membership we can make the next annual meeting a worthy celebration of this notable event. I bespeak the co-operation of all the members to that result, and invite your criticism and assistance throughout the coming year. I beg to thank you.

Mr. Alexander: I now make a motion that the Forty-Ninth Annual Meeting of the American Fisheries Society stand adjourned.

The motion was seconded and carried and President Avery declared the meeting formally adjourned.

On the following day, Saturday, October 11th, a number of the members made an excursion to Frankfort, Ky., at the invitation of the Kentucky State Game and Fish Commission, to inspect the state fish hatcheries at that place. As this meeting was informal and not a part of the regular procedure of the Annual Meeting, no report of it has come into the hands of the editor. However, judging by our experiences of the hospitality of the Kentucky Commission, it is safe to say that the trip was a thoroughly enjoyable one.

THE PRIME ESSENTIAL IN COMMERCIAL FISH CONSERVATION.

By William K. Mollan,
President, Connecticut Fish and Game Commission.

It is perhaps inevitable, it certainly is desirable, that devotees of the cause of fish conservation should become specialists; that each, having had his attention directed to some one outstanding subject among the many into which the general problem may be divided, should follow that particular branch of piscatorial research to the end, giving to its minutest ramifications the full of his thoughts. It is only by such absorbed devotion of the individual to one or another department of any science that that science attains to complete development; and the preservation and enhancement of fish life is a scientific field comparable with the best.

What the American Fisheries Society, the country and the world owe to those gentlemen who have devoted the thought and labor of their lives to the development of cold facts concerning the pollution of our waters, it is impossible to over-estimate; what is owed to the painstaking research of the students of fish habits we can never calculate, and the limitless patience and perseverance of the experimenters in artificial propagation have placed the world under heavy obligation to them.

It is only through the assemblage of the fruits of such specialized endeavor into a grand total of knowledge of the general subject that this Society finds itself in possession of a balanced mass of demonstrable facts and figures. It is only because one man has given his life to one department of research and another has followed a different line of investigation and still another a third, that the sum of available information is so much greater and more varied than any single individual has been able to find out for himself.

To the specialist, then, to the man who rides his particular hobby hard, to the individual who allows himself no leeway, but confines his labors to the development of a single-track idea, the

cause of fish life owes substantially everything. Without him, the very word "conservation" as applied to the fauna of our seas and waterways would be wholly meaningless. Instead of hope for the future we should have only regrets for a hopelessly dead past. The entire structure of present conservation effort and the blue print of the more ambitious efforts of the future are planned from data which these scientists, both professional and amateur, have supplied and are continuing to supply.

To the person already attracted to the general subject of fish life, nothing could be of more absorbing interest than the minutiae of the various steps by which our provable volume of fish lore has been gathered together.

Unfortunately, decision as to what steps shall be taken for the conservation of fish life, or how soon or on how considerable a scale, does not rest with those who have hitherto taken either a specialized or a general interest in the subject. Nor does there seem to be even a remote likelihood that there can be set up, in the minds of those on whom those decisions do rest, any ponderable degree of interest in the finer details of research and experiment. Legislators, congressmen, those persons in authority from whom we must seek action founded on economic necessity, will not use the reading glass to study the microscopic details which make up the sum of our knowledge of fish life and fisheries necessities. We shall do well if we can soon get enough of them to glance at the poster drawings which we must presistently shake before their eyes.

Such propaganda as the American Fisheries Society and kindred associations shall set afoot in the interest of the commercial fisheries must be presented in bold, splashy drawing. It must have few lines, and striking ones. It must be planned and calculated to catch the eye and the fancy of him who runs. It must be burdened with as little as possible of that circumstantiality which appeals to the initiate, but which is merely "dry scientific stuff" to the average citizen and to the average legislator.

Can we do better than to concentrate, in any effort to rehabilitate and preserve our commercial fisheries, on such obvious and elementary matters as the following:

1. Preservation of the availability, to the fish, of their natural spawning beds.

2. Protection of the fish on the beds, and during their migrations thereto.

3. Protection of the young fish from wholesale slaughter during infancy.

4. Protection of the food supply of commercially valuable food fishes.

In this very brief discussion of the problems of the country's commercial fisheries, the writer, from the limitations of his experience, necessarily approaches the subject from the viewpoint of the Atlantic seaboard states, and must confine himself to suggestions relating to those migratory fishes which would become the wards of the nation in the event of the passage of a migratory fish law comparable to the existing migratory bird law. Inland and deep sea fisheries, save in the matter of general principles, are not here considered. But even within such restricted lines there is enormous need of enlightenment among the public and the public's official servants on the broad principles of conservation; upon the far-reaching effects of present day wastage and upon the ways and means of preventing it.

It is probable that out of every hundred persons who have read at one time and another detailed, convincing statements of the injury done to fishes by the pollution of rivers, ninety-nine have jumped to the conclusion that the problem is a local one, both as to effect and remedy. And that those who have heard of the destructive effects of overfishing almost never think of those effects as bearing upon localities distant from the immediate scene of the wastage. Yet the poisoning of the waters of the Connecticut and Housatonic rivers in the writer's state have no more direct bearing on the shad supply of Connecticut than upon that of New Jersey or Maryland. It affects the entire matter of shad propagation on the Atlantic coast. It is an affair of interstate concern.

Perhaps the best possible illustration of the idea of far flung consequences of local conditions is furnished by the unspeakable practices with relation to striped bass that exist in the Roanoke river, North Carolina, where the bass are ruthlessly slaughtered by the thousands while on their way to the spawning beds. It is claimed, and certainly with considerable if not absolute truth, that the Roanoke river is the natural spawning place of by far

the greater part of the Atlantic coast striped bass. And yet the fish are being taken there in utter disregard of the rights of the fisheries of every other state on the seaboard, the entire striped bass supply of these other coastal states recklessly diminished by the destruction of the spawn bearing parent fish, and a highly valuable commercial fishery rendered unimportant where it has not been wiped out.

It is conceivable that stream pollution may be a matter of direct concern only to a certain state, when it relates to waterways which have not been chosen by migratory fishes as the scenes of their procreative activities. But when a stream has been selected by a fish species to be the nursery of its young, as the Connecticut has been chosen by the shad or the Roanoke by the striped bass, then the conditions in that stream and the laws governing them are no longer properly to be left to the control of the individual state. The stream, the spawning beds, the regulation of fishing with respect to the spawning fish, straightway become the business of the nation. To assume that the fishes of the waters of many states become the legitimate prey of the people of a single state to which they pay a temporary visit for the purpose of reproduction, and are rightfully to be exploited to the point of extermination, without adequate regulation, by the people of that state, is to deny that any American state owes the slightest obligation or duty to any other; which is, of course, an untenable position in law and ethics.

By sticking to the simpler, less complex and more striking demonstrations of the problem it should be possible to bring to members of congress the conviction that unless all the food resources and industries embodied in the groups of salt water fishes that spawn in inlets and rivers are to be wiped out, the federal government must assume control.

The pollution of the waters of spawning areas must be forbidden by national enactment.

Fishing on spawning areas must be forbidden and the fish protected against capture while on their way to the areas, by national enactment.

The netting of immature fishes must be prevented by regulating the size of net meshes, by national enactment.

In other words, there can be no adequate betterment of conditions with relation to our migratory coastal fishes until the real owner of those fishes, our Uncle Samuel, bestirs himself to safeguard his own interests, instead of trusting the task to individual states which will never assume responsibility for what is not their own and in the nature of things cannot be theirs.

This leaves one other division of this subject to be considered. It is one that has been far too much neglected. I refer to the protection of the food of food fishes.

Some time ago there was prepared by a statesman of one of our Atlantic states a bill providing legal protection for many varieties of salt water fishes. It was carefully drawn, this bill, and it would have restricted the taking of this fish and that, always with a view to conserving the species while permitting the capture of merchantable specimens in considerable quantities. It protected the bluefish, the bonito and all the rest of the predatory varieties that live upon finny bait fish, but it said not a word about the menhaden. Under the law the last menhaden in the world might have been legally destroyed, yet the menhaden is the fundamental food of half the varieties this man was so solicitous about! And incidentally it has been for years the most ruthlessly slaughtered form of life in the ocean.

Thirty or forty years ago the waters of the North Atlantic for hundreds of miles along the American coast fairly teemed with countless millions of menhaden. The peculiar milling wake of a hundred vast schools of these creatures could be noted in any summer day's sail upon these waters. And as the menhaden swarmed, so proportionately thrived the blue fish, the bonito and other large fishes of the mackerel family, which followed and fed upon the illimitable supply of menhaden bait. The whole north Atlantic seaboard in those days was alive with edible fishes of the finest varieties, all regular boarders at the menhaden table.

Even in those days there was a snug little industry in the production of menhaden oil and fertilizer. But the catches made little apparent inroad on the supply, which seemed inexhaustible. Then came the formation of great companies that built big vessels and employed new and gigantic devices in the capture of the "bony fish," as they call them in New England. By and by the menhaden began to grow scarcer. They were taken at all seasons

and in all waters, finally even chased into the inlets where the last of the great schools sought refuge. The menhaden were overfished out of existence, or nearly so. When they disappeared, then too disappeared, in very large measure, the fine, valuable food fishes which depended for their existence upon the existence of their natural prey.

There has never been the slightest prospect of successfully regulating the taking of menhaden by the individual states. The menhaden fisheries were highly profitable and controlled by influential capitalists, and it was useless for one state to adopt restrictive laws which were not in force in the neighboring states. But if we had had, during the last twenty-five years, a federal migratory fish law which included the protection of the most important element in the whole category of coastal fishes, the food of food fishes themselves, it is a hardy soul who will contradict the guess that the take of food fishes of the blue-fish and bonito class, in the year 1919, would have been ten times what it will be this year.

Give us a sane and just federal migratory fish law, providing at once all proper liberty for present fishing and a rational regard for the fishing of the future, and above all protecting from extinction or undue depletion the sustenance of the fishes, and there will be restored to the people of the country a highly important food factor now become almost negligible, and to the pockets of the fisherman of our costal states many millions of dollars annually.

THE CHESAPEAKE BAY.

By Talbot Denmead,
Chief Deputy of the Conservation Commission of Maryland.

The purpose in selecting this subject is to give me something to talk about which I know intimately, for it is with considerable hesitancy that I address this body. As you are all so much better acquainted with fish and fish matters than myself, who have always been a hunter first and a fisherman next, I feel that if there is any message I can bring to you it will be about conditions affecting my own Chesapeake, where I am at home.

The Chesapeake Bay lies entirely within the states of Virginia and Maryland, the former controlling the lower waters, or south end of the bay, where the fish enter from the Atlantic Ocean, and the latter controlling the northern waters, where the fish go to spawn. Since the time of George Washington there has been an unending dispute between these two states over the proper regulations pertaining to fish, oysters and crabs, and probably there always will be, unless the Federal Government assumes control over migratory fish that pass through one or more states in reaching their breeding grounds.

The Chesapeake Bay is unequaled in the country by any similar body of water. Its shore front, if stretched out in a straight line would reach from Maine to Florida; its waters teem with many varieties of fish and crabs; its bottom is covered with the finest oysters, and wild-fowl rest upon its not always placid bosom. Weakfish, striped bass, white perch, yellow perch, pickerel, large mouth bass, spot, king fish, blue fish, butter fish, catfish and wall-eyed pike are some of its fish.

At the head of the bay lies the Susquehanna Flats, a great spawning ground for many fish, as well as a noted feeding ground for wild fowl, where the celebrated canvas-back congregates in quantities, to feed and grow fat on the enormous beds of wild celery. Upon these flats flows the mighty Susquehanna River, after traversing the state of Pennsylvania, in whose clear and rapid waters the angler finds heaven in fighting the great striped bass and the smaller black bass.

Fish Refuges.

Places where fish can spawn undisturbed by the netters is not a new proposition, but it has been tried with such success in several instances in Maryland that I am compelled to give you in detail the history of one of our successes along this line. This is one of the subjects in which I hope to interest you, namely: the experiment of prohibiting all netting in the Severn River, a tide-water tributary of the bay. Many years ago the fish had practically been cleaned out of this beautiful river by all kinds of nets, and it was not very hard to get the legislature to pass a law barring the netter. Two years of re-stocking, however, and the abolishment of the net, brought the fish back into this river in such quantities that the commercial fishermen made a concerted effort to repeal the law, and get into the river with their nets. Being defeated in this, they tried violating the law. The increase of fish had been so remarkable, however, that public opinion was against a repeal and the violators, and at the following session of the legislature the law was considerably strengthened. Violators were apprehended, convicted and fined, and they then decided it was wise to leave the river alone. The fish have continued to increase, notably the striped bass and white perch.

Now the beauty of this experiment was that it not only increased the supply of fish within the river, but actually served as a feeder for the waters of the bay surrounding the mouth of the river. In time this extended many miles away, thereby materially benefitting the commercial fisherman by providing a safe nursery for food fish until they were of marketable size and there were larger quantities outside in the bay where he could fish.

This experiment, or plan, for it is beyond the experimental stage, has also been tried in two other Maryland estuaries, namely, Dundee Creek and Sue's Creek, with very satisfactory results. It is well worth while and we hope to see the time very shortly when we have such refuges in every county in Maryland.

Federal Control of Migratory Fish.

The other point I wish to emphasize is the necessity of some control, other than state control, over fish which winter in the sea and pass through one or more states to reach their spawning

grounds, such as is the case in the Chesapeake and other waters of the country. In our case it has been proven beyond question that state control proves a detriment to the interests of both states. This has been especially marked in regard to crabs which wintered in Virginia and were dug out of the mud during the winter months, and it was of no use for Maryland to try to protect them during the time they were in the waters of the latter state. The shad is another illustration. Entering the bay in Virginia on its way to the head of the bay to spawn, it is beset by nets through the entire length of the bay. Neither state is willing to give any protection which might in the least benefit the other state, and consequently the shad is a fair prey from the minute he sticks his nose into the Chesapeake. It is no wonder that less than one per cent of the shad reach their spawning grounds, though at least ten per cent, with the assistance of fish hatcheries, must reach the spawning beds to keep up the stock. This resulted in the closing of the United States Shad Hatchery at the head of the Chesapeake, as it was unable to obtain a sufficient number of eggs to pay for operating. The Conservation Commission of Maryland, however, has operated several floating hatcheries with considerable success, and is to be commended for its uphill fight for saving this fish, but, without Federal control, it is my opinion that little can be accomplished.

In conclusion let me say that co-operation and common sense are just as necessary in fish protection as in any other matter. No two states pulling different ways will get anywhere. I shall close without further remarks excepting to recommend to you *Fish Refuges and Federal Control.*

RAISING FRESHWATER MUSSELS IN ENCLOSURES.

By Roy S. Corwin,
Scientific Assistant, U. S. Bureau of Fisheries.

Results of artificial infections of *Lampsilis luteola* on the gills of several species of game fishes, confined in enclosures in Lake Pepin, are throwing considerable light upon the problem of commercial propagation of fresh-water mussels for button purposes. Experiments begun in May, 1918, and continued up to the present, have been particularly instructive.

In order to make a quantitative test of methods of artificial propagation, enclosures or pens were constructed with board bottoms and sides of one inch mesh wire netting. The bottoms of the pens were covered to the depth of about one inch with sand taken from the shore above the water line. The pens were then submerged in water about five feet deep. Three localities in Lake Pepin were used: Lake City and Frontenac, Minnesota, and Stockholm, Wisconsin. A brief summary of the operations and findings in connection with several of the enclosures follows.

Lake City Enclosure

Five lots of fishes, consisting of wall-eyed pike, sauger, small-mouthed black bass, white bass, yellow perch, sunfish and crappie, infected with the glochidia of *Lampsilis luteola*, on dates extending from May 16th, 1918, to July 3rd, 1918, were confined in the Lake City enclosure. This enclosure was 12 feet square and had sides from 6 to 12 feet in height. After deducting the number of fishes which died and those which either escaped from the pen or were caught out by fishing parties, it was found that 79 fishes had remained alive in the enclosure long enough to drop the young mussels.

From this enclosure on September 23rd, 1918, after a maximum of 130 days from the date of the first infection, were removed 11,199 live juvenile *L. luteola*, ranging in size from 16.0 millimeters to 3.0 millimeters. On previous dates 395 live juvenile luteola had been removed, making a total of 11,594 from the pen. To this might also be added 1000 pairs of valves of dead juvenile luteolas, making a grand total of 12,594.

On September 30th, 1918, approximately 11,000 of the live juveniles were returned to this pen, which was resubmerged in the lake to a depth which would enable the young mussels to escape freezing. Certain ones were measured carefully and numbered, and their dimensions recorded. These mussels were not disturbed until September of this year, when the pen bottom was raised and its contents examined.

The average growth of the mussels during the second year was found to be 16.72 millimeters. Only 80 live mussels were recovered, the largest being 37.0 and the smallest 6.7 millimeters long. An attendant circumstance was that hundreds of the second season mussels had been eaten by a turtle or bottom-feeding fish. A quart jar of shell fragments, hinges and umbones, showing first season shell plus part of the second season's growth, was recovered. These fine, strong shells had been crushed by the jaws of a mussel devouring animal. A count of hinges and pairs of umbones showed that 2,085 mussels had been destroyed in this manner. Thus the total yield of second year shells should have been approximately 2,165, which would still be less than one-fifth of the number of first season juveniles replanted in September, 1918.

Frontenac Enclosure

During July, 1918, infected fishes were confined in the enclosure at Frontenac, which was 10 feet square and had sides from 6 to 9 feet high; 46 of the infected fishes dropped young mussels in the pen. Due to the lateness of the season, the bottom of the pen was but partly examined on November 11th, 1918, and no exact estimate of the number of juveniles was obtained, although several juvenile luteola were recovered which were from 4.0 to 2.5 millimeters long. These were returned to the pen, which was resubmerged.

On September 12th, 1919, 480 second season luteolas were recovered, the largest 30.8 and the smallest 7.4 millimeters in length. The average second season's growth was 19.35 millimeters.

Stockholm Enclosure

Infected wall-eyed pike placed in the enclosure at Stockholm on August 6th and 14th, 1918, were still carrying practically the original number of glochidia on their gills when released on

November 10th, 1918. Although it was evident that but few, if any, young mussels had been dropped in this pen before the removal of the fishes, still the pen was resubmerged and left until September of this year, when it was raised and examined.

Seventy-two second season mussels were found. These showed clearly the first season shell, which measured from 1.4 to 2.3 millimeters, beyond which extended the second year's growth. The largest juvenile luteola from the Stockholm enclosure was 21.6 and the smallest 7.3 millimeters long. The average second season's growth was 15.26 millimeters.

1919 Enclosures

The experimental work during the present season was conducted so as to show the relation of the length of the parasitic period to season and temperature of the water. The enclosures were constructed in two parts; a board bottom and a wire netting cage resting upon it which could be raised when desired. In all, 14 such enclosures were employed. Infections were made at about 15-day intervals from May 20th to September 4th. Several infections were made simultaneously in each of the three localities previously mentioned.

Generally speaking, it was found that glochidia placed on fish up to the middle of July, that is, in spring and early summer infections, required a shorter period for metamorphosis than those used in infections after July, late summer and fall infections. For instance, spawn placed on fish May 20th, dropped from the host in from 26 to 29 days, when the water temperature was rising from 60 to 78 degrees F. Spawn placed on fish June 5th dropped off in from 18 to 20 days—water temperature 68 to 78 degrees F.

Fishes infected July 1st, carried the young mussels from 14 to 68 days—water temperature falling 77 to 74 degrees F.

A significant observation was made on the behavior of old glochidia, that is, those which had been carried by the parent over the winter and spring; and new glochidia, that is, mature ones of the present season. On July 17th, two lots of fishes of the same species were infected and kept in separate but adjacent pens. The first lot was infected with old glochidia; the second lot was infected with glochidia of the present season. The first lot had completely dropped the young mussels within 14 days. Some

of the second lot of fishes were observed to be free from glochidia within 27 and 32 days, respectively, after infection. Others continued to carry as late as October 1st (92 days) and were kept in the enclosure for further examination.

From this it is believed that the least time for metamorphosis is required by glochidia taken from the parent shortly before the time when the parent would normally discharge the spawn preparatory to refilling the marsupial pouches, that is, during the month of July. The instances in which certain fishes infected July 1st dropped some mussels within 2 weeks and carried others 8 or 9 weeks, are explained by the fact that both old and new glochidia from several mussels had been used in the infection.

Late summer infections, those August 5th, August 19th and September 4th, require long parasitic periods, since fishes, when examined October 1st were found to be still carrying almost the original infection.

Glochidia placed on fish May 20th, 1919, grew to be mussels 5.5 millimeters long on July 26th (67 days); 11.0 millimeters long on August 27th (99 days), and 17.0 millimeters long on October 1, 1919 (134 days).

It is still too early to state the number of mussels raised per fish, but it is expected that this can be done before the close of the season.

BENEFICIAL RESULTS OF THE INTRODUCTION OF PLANT LIFE IN TROUT PONDS AT THE NEW JERSEY STATE FISH HATCHERY.

By Chas. O. Hayford,
Superintendent, Hackettstown, N. J.

The rearing of brook trout at New Jersey State Fish Hatchery, located at Hackettstown, N. J., during the first year of operation (1913) was very successful, but the work of the second, third and fourth years proved quite discouraging. During these years, after the fish had reached a length of from 1½ to 3 inches, we had trouble with them until they attained to 5 or 6 inches. Brown trout were affected in the same manner as the brook trout, but not to such an extent.

During the second year, 1914, we experimented with various foods. For the fish that had reached 1½ inches, the best results were obtained with the use of a mixture of meat and butter-fish in the proportion of 1 to 1. Oxygen tests proved of value as to the number of fish we could carry in the ponds.

Some fish culturists we consulted were of the opinion that the concrete pools were causing the trouble and that dirt pools would give better results. I had used both types before coming to Hackettstown and preferred those of concrete as being more sanitary.

The use of dirt ponds during the third year, 1915, proved quite satisfactory for fish that had attained a length of 2 inches, but were of no value for small fish on account of the profuse growth of the alga, *Spirogyra*. The removal of the *Spirogyra* necessitated the continual stirring up of the ponds, while, on the other hand, if it were not removed, gill trouble developed among the small fish. The fish did poorly under both conditions.

During the fourth year, 1916, tests carried on in two ponds, 50 by 180 feet, and 3 to 5 feet in depth, produced only 25,000 fingerling trout, whereas four times that number might reasonably have been expected. Two similar ponds proved satisfactory for yearlings, 6,000 fish, 6 to 8 inches long, having been produced in each pond.

In order to hold the water at a low temperature it was necessary to use more water than could well be spared, until the supply from a new reservoir became available. The water, with a temperature of 55 degrees F. on entering the first pond at the rate of 20,000 gal. per hour, was 74 degrees F. on leaving the second pond. The water remained at 74 degrees for only a short period during each day and would then drop back to 58 or 56 degrees during the night. A large mortality among the small fish under two inches long was the result of this fluctuation in temperature. The large fish did not seem to be affected by this temperature unless subjected to it for a prolonged period. Four small spring-fed ponds, three of concrete and one of dirt, with water at 52 to 60 degrees and with aquatic growth consisting of *Elodea* and *Potamogeton crispus*, gave good results. We introduced these plants into large ponds and obtained good results with yearlings and breeders, but not with small fish.

We also discovered that affected fish, placed in waste water running from ponds that contained an abundance of *Potamogeton crispus*, *Elodea*, water-cress, snails, shrimp, stoneflies, caddisflies, *Asellus* and black fly larvae, soon became very active and healthy. Microscopic examinations of the heart's blood showed no *Bacterium truttae* in a great many fish, while others showed only slight traces of disease.

The fifth year, 1917, we took two chains of ponds, ten each, and brought in a supply of water from a four-acre pond. This was supplied by spring and brook water, with a temperature of from 70 to 75 degrees F. and contained *Potamogeton crispus*, *Elodea*, water-cress, snails, shrimp, stoneflies, caddisflies, *Asellus* and black fly larvae. We set valves on the pipe line supplying spring water of 52 degrees and pond water of 72 degrees to get an average temperature of 62 degrees, which was similar to conditions of the brook water previously described. Everything worked well and we thought we were on the right track until on September 1st, we got an outbreak of a disease caused by a protozoan known as *Ichthyophthirius multifillis*.

The sixth year, 1918, in ponds 50 by 180 feet, which were the same as those employed in 1916, we obtained tangible results by running a sufficient quantity of water through to keep temperature below 65 degrees, about 35,000 gallons per hour.

In February of the present year, the President of our Department gave me permission to engage Mr. Wm. T. Foster, Professor of Biology in Lafayette College, to give scientific assistance in carrying on experiments. Wednesday and Saturday of each week were devoted to this work which extended to July first. Special attention was given to the more important diseases affecting brook, brown and rainbow trout.

In view of the fact that this disease was confined to certain pools, Professor Foster, by microscopic examination, was soon able to discover the disease organisms in those fish showing pathologic symptoms, for the purpose of discovering some means of preventing the disease or effecting a cure as the disease appeared. These examinations began in February and are still being carried on. Hundreds of brook, brown and rainbow trout were examined to ascertain the cause of the disease conditions which appeared from time to time.

There were two very important diseases with which we came in contact. One was a blood disease, caused by the microscopic organism known as *Bacterium truttæ*, and the other by a protozan known as *Ichthyophthirius multifillis*. (A translation of pp. 122-128 of Hofer's Fischkrankeiten, München, 1904, was furnished by the U. S. Bureau of Fisheries). The prescribed measures were employed and proved efficacious.

In the case of the first named disease the fish could be readily picked out and every fish exhibiting typical pathological conditions showed the presence of the organisms in large numbers in the heart's blood. The morphological characteristics of these organisms have been fully described by Mr. M. C. Marsh, formerly of the U. S. Bureau of Fisheries, but so far as we have been able to ascertain, no direct preventive or curative measures have been discovered up to this time. We have not carried on our investigations far enough to entirely eliminate the organisms, but we have succeeded in eliminating the disease this year in some of our ponds and in reducing the mortality in others more than 90% by employing the following methods:

Introduction of *Potamogeton crispus*, *Elodea* and water-cress in clusters, to the extent of about ten per cent of the pond area in ponds of spring water at 52 to 62 degrees. In ponds 50 feet long and 7 feet wide with a depth of water of 2 to 2½ feet, it is necessary

to introduce new plants every three or four weeks, in order to enable them to grow to the surface to attract the various flies and insects. New plants starting from bottom should be controlled so that the excrement from the fish will not lodge and foul the ponds. Keeping them in clusters prevents fouling, as men can work around them from the top of the walls with long-handled brushes.

We then place in the pools according to the number of the fish, one or two galvanized iron boxes, 18 inch sq., 24 gauge, open at the bottom, with a one-inch iron band around the bottom. Holes are drilled through the band for 5-16 inch iron rods, used to hold a wood frame containing trays for fly-blown meat. A small pin hole is punched through the top to permit the gas to escape, in order not to kill maggots. The bottom of this box is submerged one inch in the water to do away with objectionable odors. Any stale or tainted meat will do. The big blue flies produce the largest maggots. Care will have to be taken to keep beetles away from the meat or they will destroy the fly maggots as fast as they hatch.

Also we thoroughly roil ponds twice a week. One half yard of field loam to twenty ponds is sufficient.

Tables.

It will be noted by the table that the losses of brook trout for the month of July is 16.5%, brown trout fingerlings 61.4%, brown trout yearlings 6.7%, rainbow trout fingerlings 1.3%, rainbow trout yearlings 7.3%. Loss of all kinds 18.9%.

August losses—Brook trout fingerlings 1.7%, brown trout fingerlings 1.9%, brown trout yearlings 4%, rainbow trout fingerlings 99-100 of 1%, of rainbow trout yearlings 5.6%. Loss of all kinds 2.2%.

September losses—Brook trout fingerlings 1.2%, brown trout fingerlings 3-50 of 1%, brown trout yearlings 1.4%, rainbow trout fingerlings 1-50 of 1%, rainbow trout yearlings 1.3%. Loss of all kinds 1-20 of 1%.

The above losses occur in spring water at 52 to 62 degrees. The same fish were used for the entire period.

DAILY LOSS, MONTH OF JULY.

DATE	No. brook trout fingerlings used in test—1,000.	No. brown trout fingerlings used in test—54,000.	No. brown trout yearlings used in test—11,000.	No. rainbow trout fingerlings used in test—100,000.	No. rainbow trout yearlings used in test—34,000.	Total 200,000
July 1.....	10	1852	23	4	50	1939
" 2.....	12	2320	80	0	80	2492
" 3.....	11	998	32	7	54	1102
" 4.....	12	1119	46	11	60	1248
" 5.....	9	1815	25	23	80	1952
" 6.....	11	1644	28	34	64	1781
" 7.....	13	1474	30	15	91	1623
" 8.....	9	1859	7	8	57	1940
" 9.....	12	1419	10	15	90	1546
" 10.....	8	3197	10	10	55	3280
" 11.....	7	2519	15	19	84	2644
" 12.....	5	2195	11	40	105	2355
" 13.....	9	1889	44	29	75	2046
" 14.....	8	1582	32	17	91	1730
" 15.....	6	986	12	25	111	1140
" 16.....	5	566	14	11	106	702
" 17.....	4	776	11	34	108	933
" 18.....	3	650	24	11	130	818
" 19.....	2	320	27	14	76	439
" 20.....	1	474	19	12	52	558
" 21.....	0	520	19	11	48	598
" 22.....	1	497	25	17	57	597
" 23.....	2	474	18	2	70	566
" 24.....	1	254	20	24	123	422
" 25.....	2	608	29	755	101	1495
" 26.....	0	474	18	2	70	564
" 27.....	1	297	14	7	66	385
" 28.....	0	176	22	13	82	293
" 29.....	1	111	20	28	74	234
" 30.....	0	52	28	34	105	219
" 31.....	0	60	23	60	85	228
	165	33,177	736	1,292	2,500	37,870
	Loss 16.5%	Loss 61.4%	Loss 6.7%	Loss 1.3%	Loss 7.3%	Loss 18.9%

DAILY LOSS, MONTH OF AUGUST.

DATE	No. brook trout fingerlings used in test—835.	No. brown trout fingerlings used in test—20,823.	No. brown trout yearlings used in test—10,264.	No. rainbow trout fingerlings used in test—98,708.	No. rainbow trout yearlings used in test—31,500.	Total 162,130
Aug. 1	1	49	25	70	55	200
" 2	1	24	20	16	97	158
" 3	0	22	29	25	89	165
" 4	1	20	4	54	80	159
" 5	0	19	15	73	58	165
" 6	0	11	15	35	73	134
" 7	0	9	11	18	81	119
" 8	1	8	11	24	89	133
" 9	0	6	8	33	79	126
" 10	0	16	13	28	85	142
" 11	1	26	13	26	64	130
" 12	1	14	12	28	62	117
" 13	0	11	16	32	60	119
" 14	0	16	20	18	72	126
" 15	1	12	27	45	66	151
" 16	0	9	20	35	60	124
" 17	1	12	24	40	63	140
" 18	1	14	28	40	70	153
" 19	1	17	4	35	70	127
" 20	0	16	19	30	64	129
" 21	0	15	15	28	68	126
" 22	0	14	18	29	69	130
" 23	0	2	2	47	22	73
" 24	0	4	8	40	24	76
" 25	1	6	10	38	17	72
" 26	0	7	1	16	12	36
" 27	0	0	9	17	24	50
" 28	1	3	4	15	26	49
" 29	1	7	4	10	19	41
" 30	1	5	5	18	14	43
" 31	1	9	8	22	30	70
	15	403	418	985	1,762	3,583
	Loss 1.7%	Loss 1.9%	Loss 4%	Loss .99%	Loss 5.6%	Loss 2.2%

DAILY LOSS, MONTH OF SEPTEMBER.

DATE	No. brook trout fingerlings used in test—820.	No. brown trout fingerlings used in test—20,420.	No. brown trout yearlings used in test—9,846.	No. rainbow trout fingerlings used in test—97,723.	No. rainbow trout yearlings used in test—29,738.	Total 158,547
Sept. 1	1	1	4	8	10	24
" 2	0	1	3	10	14	28
" 3	0	0	8	10	11	29
" 4	1	0	7	6	21	35
" 5	0	1	4	8	16	29
" 6	0	0	13	6	12	31
" 7	1	1	9	3	10	24
" 8	1	0	4	2	7	14
" 9	0	1	4	7	15	27
" 10	1	0	5	4	10	20
" 11	1	1	3	6	12	23
" 12	0	4	2	5	28	39
" 13	1	1	1	3	16	22
" 14	0	0	1	4	20	25
" 15	0	0	4	8	12	24
" 16	0	11	1	6	8	26
" 17	0	7	6	4	7	24
" 18	0	5	4	0	7	16
" 19	1	10	18	5	13	47
" 20	0	10	6	7	25	48
" 21	1	8	9	5	20	43
" 22	0	12	6	7	24	49
" 23	0	9	4	17	0	30
" 24	0	6	0	7	25	38
" 25	0	5	2	0	13	20
" 26	0	6	3	9	10	28
" 27	1	11	0	6	9	27
" 28	0	8	6	14	13	41
" 29	0	2	3	10	16	31
" 30	0	2	0	36	5	43
	10	123	140	223	409	905
	Loss 1.2%	Loss .06%	Loss 1.4%	Loss .02%	Loss 1.3%	Loss .57%

THE PRESERVATION OF THE ALEWIFE.

By David L. Belding,
Biologist of the Massachusetts Fish and Game Commission.

The problems confronting the commercial fisheries offer a most fertile and important field of investigation for economic biology. Unlike the majority, the alewife fishery presents a complete problem in itself, and, because it furnishes a splendid illustration of the practical value biological study may play in the preservation of a commercial fishery, it has been chosen for the subject of this paper.

The alewife or branch herring (*Pomolobus pseudoharengus*) is the most abundant food fish inhabiting the rivers of the Atlantic Coast, from Maine to Florida, and with the disappearance of the shad has become commercially the most valuable anadramous fish in Massachusetts. Ever since the landing of the Pilgrims, when the alweife provided the most readily available source of food for the early inhabitants of New England, it has been closely related to the prosperity of the shore towns, where it has always been held as a public asset. The successful re-establishment of this fishery would benefit the shore towns directly, and indirectly would prove of even greater value to the public.

The alewife is of value as food, as bait, and as a food supply for other fish. Either fresh or cured, the alewife forms an excellent and inexpensive article of diet. Because of its abundance and comparative cheapness, it is satisfactory as a bait supply. However, of greater importance is the attraction it forms for large schools of pollock, bluefish, striped bass, squeteague and other food fishes, which come to our shores to prey upon the young alewives when they descend the coastal streams. The simultaneous decline of the alewife and shore fisheries suggests that there is a direct relation between the two, and that the success of the fishing towns along the coast is dependent in a considerable measure upon the flourishing condition of the alewife fishery.

This paper presents the results of a biological study of the Massachusetts alewife fishery, and the practical application of remedial measures based on this study.

Its presentation naturally falls into three divisions:

I. Natural history of the alewife.
II. Present condition and decline of the fishery.
III. Application of remedial measures.

I. Natural History.

Distribution.—While the majority of the numerous herring species are confined to the ocean, some ascend the rivers for the purpose of spawning. In the latter class is the alewife, which is taken commercially along the Atlantic Coast from Nova Scotia to Virginia. In Massachusetts practically all the coastal streams in former days were inhabited by this fish, but, at the present time in many localities the fishery no longer exists.

Reproduction.—During the spawning season, which lasts from March to July, the alewife ascends the tidal streams to deposit its spawn in the fresh ponds, and later returns to the ocean. Two classes of spawning ponds are found in Massachusetts: (1) The ordinary tributary tidal stream with one or more fresh water ponds at its source, at a variable distance from the ocean, and (2) the typical fresh or brackish water shore pond, separated from the salt water by a narrow sand beach, through which passes a natural or artificial channel.

The adhesive eggs are deposited in shallow water, where they adhere to stones, gravel, sand, logs and other materials. During the act of spawning, the alewives swim in small schools around the edges of the pond, one female being commonly accompanied by 6 to 7 males. The temperature of the water is the principal factor regulating the time of spawning and rate of development of the eggs, warm water accelerating the process of hatching. The incubation period for artificially hatched eggs ranges from 48 to 96 hours with a water temperature of 67 to 72 deg. F.

Growth.—The alewife when hatched is about one-fifth of an inch in length, but, under normal conditions, rapidly increases in size, becoming a slim, translucent creature with broad tail, prominent dorsal fin, and relatively large eye. The young alewife attains the approximate length of two to four inches by fall, at the time it descends from the breeding grounds to the ocean. At one year, when detained in fresh water, it measures about 6 inches.

Its subsequent growth is somewhat a matter of conjecture. Adult fish range from 7 to 12.5 inches, the majority, presumably three and four year olds, running from 10 to 12 inches.

In late summer schools of various sized alewives are found in the spawning ponds, depending upon the following factors:

(1) Geographical location, spawning taking place earlier in southern waters.

(2) Time of spawning, eggs from the first run hatching two months earlier than the last.

(3) Temperature, abundance of food supply, and size of spawning ponds.

Food.—The food of the adult alewife consists mostly of the plankton forms, such as diatoms, algae, and small crustaceans. Instances have been cited where alewives have risen to the artificial fly, and also have been taken with young eels as bait.

Enemies.—Among the enemies of the young and adult may be mentioned fish, birds, disease and man.

Migration.—The history of the alewife in the interval between its descent to the ocean and its return as a mature fish is as yet unknown. We are better acquainted with the freshwater part of its life cycle. Governed primarily by temperature, the fish approach the coast at a definite period in the spring, appearing first in the rivers of the Middle South as early as March, and in Canada in May. In Massachusetts they usually are noticed toward the last of March or the first of April. After spawning, the adult fish return to salt water in a lean, emaciated condition. Whether these fish spawn again has not been determined.

Parent Stream Theory.—From observations in handling local alewife fisheries, the "Parent Stream Theory" has been evolved. Briefly, the theory is that the young alewives descending from a particular pond and stream will return as adult fish to the same stream for spawning, thus establishing a continuous chain. There are good reasons for us to consider this theory favorably. Practical demonstration has shown that fisheries have been created in streams which had no alewives by the simple expedient of placing mature spawning alewives in the headwaters. The offspring returned as adult fish, to the same spawning grounds, thus establishing a fishery. Similarly, depleted fisheries have been re-estab-

lished. Experience has likewise shown that a poor year, when but few alewives reach the spawning grounds, is followed at a stated interval by a corresponding lean year. From such observations we can accept the "Parent Stream Theory" as the best working hypothesis available.

II. The Fishery.

Operation.—In Massachusetts there are two types of alewife fisheries, the natural and the artificial, both of which have been developed under town control. In early days nearly every coast town possessed one or more natural streams upon which fisheries were soon established under town management, and in a few cases by private individuals. Unless the fishery was completely ruined, its operation was conducted in one of four ways: (1) free, (2) town operated, (3) leased, and (4) private ownership.

Methods of Catching.—Every householder was early given the time-honored privilege of obtaining alewives, in whatever manner and at whatever time he desired. Later, when the towns exercised control over the alewife fisheries, certain places were designated and set aside by law as locations where alewives could only be taken, and fishing was forbidden elsewhere. These stations have been developed by regulating the water flow, and by building screened locks and weirs, in which the alewives are taken on stated days of the week. From the catching pens, the alewives are removed by seines, or dipped with scoop nets, according to the method best suited.

Marketing.—While the majority of the fish taken during the spring run are cured, an increasing number are marketed fresh. In 1918, Boston alone used over 2200 barrels of fresh alewives, showing that the value of the alewife as a food is becoming more appreciated.

Decline.

While in some streams the alewife fishery has held its own, or even improved, it has diminished to such an extent usually that we can accept without reservation the general statement that the alewife fishery as a whole has declined. The causes which have contributed to this condition are so numerous and so complex that the exact separate influence of each cannot be absolutely deter-

mined. Four prominent factors are (1) destruction of the spawning grounds, (2) obstructions which prevent the alewives from passing to the spawning grounds, (3) pollution of streams, and (4) overfishing.

Destruction of Spawning Grounds.—Many alewife streams which once were important can never be restocked because their former spawning grounds are no longer available. Some have been taken for water supplies, screened, and the original outflow diverted. Natural agencies and artificial changes such as drainage and deforestation have altered spawning grounds and streams.

Obstructions.—One of the first steps in the development of a fishery is the removal of all obstructions to give free access to the spawning pounds. Natural changes may alter the course or flow of streams in such manner as to prevent the passage of fish. Natural or artificial falls, dams, unless equipped with fishways, and material of various kinds prevent or make difficult the passage of alewives.

(1) *Dams.*—Dams are the inevitable result of the inroads of colonization following the waterways. In former days water power was even a greater necessity than in the present era of coal, gas and electricity. As manufacturing became of greater moment, more water power was required, and eventually numerous dams were erected upon the streams of Massachusetts. The mere presence of dams is not dangerous. Only when they are unequipped with fishways or are not opened during the spring run do they become a menace. Properly supplied with adequate passageways, dams would never have exerted a pernicious influence upon the alewife fishery.

(2) *Cranberry Bogs.*—A water supply is essential for the successful operation of the cranberry industry, and in southern Massachusetts numerous bogs are found along the alewife streams. The cranberry industry affects the alewife fisheries by:

(*a*) The erection of small dams usually not equipped with fishways, the owners of which are supposed to raise their sluiceboards during the annual run. However, at certain seasons for the welfare of his bog, the owner may find it desirable to have the water remain for a longer period, and thus block the progress of the fish.

(*b*) Changing the course of the stream by ditches and canals which are inferior to the natural channels.

(*c*) Temporarily flooding the bogs during the early fall, thus stranding the young alewives which are descending to salt water.

Pollution.—There are two sources of pollution in the coastal streams, (1) sewage, and (2) manufacturing wastes. The former comes from sewage systems and from private houses; the latter from mills of various kinds located on the streams.

Pollution affects fish in three ways: (1) by directly interfering with the normal habits of the adult fish, (2) by destroying the eggs and young, and (3) by indirectly affecting the environment and food supply.

Overfishing.—The principal cause of the decline of the alewife fishery has been overfishing as a result of unwise regulation. Unless a reasonable number of adult alewives are permitted to reach spawning grounds, the destruction of any fishery is inevitable. Almost universally, overfishing has been brought about by faulty methods of regulating the industry through town control, which is the common practice in Massachusetts. The alewife streams where the public is given the privilege of free-for-all fishing under various obscure regulations, most of which are seldom enforced, have become the poorest producers. Fisheries directly operated by towns are also unsuccessful, owing to laxity in management, and to town politics. The popular and easy expedient of annually leasing the fishery to the highest bidder has placed a premium upon its exploitation, and has directly encouraged overfishing. Naturally the purchaser, uncertain of obtaining the fishery for the future years, would drain its resources to the utmost by taking all available fish.

III. Remedial Measures.

As briefly outlined in the previous pages, the biological investigation of the Massachusetts alewife fishery has shown its present condition, the causes contributing to its decline, and has brought out certain points in the life history and habits of the alewife which furnish a basis for establishing cultural methods.

The requisite steps in this reconstruction work are:

(1) An unobstructed and uncontaminated passageway from salt water to the spawning grounds.

(2) Artificial restocking of depleted streams and the creation of new fisheries in favorable localities.

(3) Adequate and efficient methods of regulating the fishery.

In the spring of 1919, the work which had been suspended during the war was resumed, and first of all the important problem of obtaining a clear passageway for the fish to the spawning grounds, as a preliminary requisite for stocking was taken up. At the same time preliminary cultural work, including the artificial hatching of alewife eggs guaranteed beyond a reasonable doubt the future success of restocking the depleted streams.

FISHWAYS.

The first step in the reconstruction of the alewife fishery is the removal of existing obstructions to make a clear passageway for alewives. Two conditions present difficult problems—impassable dams and pollution. The first and most important has been met by installing workable fishways, the latter is still unsolved.

Requirements.—The requirements for a successful fishway are: (1) Easy and rapid passage for all species of fish, with uniform flow of water, gradual ascent, and absence of high barriers. (2) A minimum sacrifice of water in the interest of the dam owners. (3) An entrance into which the fish are readily directed. (4) A firm, solid construction, resistant to freshets, or one which may readily be removed when not in use.

Installation.—The chief point to remember is that it is not the type of fishway, *but how it is installed*, which determines its success or failure, since each dam presents certain peculiarities which necessitates individual treatment. In installing a fishway the following conditions must be considered:

(1) Water Flow.—Provision for a constant flow of water, irrespective of variations in the level of the pond, can be made by an adjustable upper section of the fishway to correspond to the water level, a gate situated at the lowest probable water line, or several gates at different levels.

(2) Entrance.—Instinctively the fish follow the greatest flow of water, usually up the main stream to the dam. Therefore, the entrance must be either directly beneath the dam where the fish will naturally swing into it, or there must be some means of

directing them. Screening the stream with an iron grating is a successful though expensive method. A submerged stone barrier leading to the fishway entrance has proved at times effective.

(3) CONSTRUCTION.—The nature of the soil and height of the dam largely influence the difficulty and expense of construction.

(4) DESTRUCTION.—Destruction of a fishway by spring floods may be partially avoided by building a concrete structure, locating the fishway where it is subject to the least damage, and having part or all removable when not in use.

Standard Fishways.—A successful fishway which will take all species of anadramous fish has never been invented. In our work two types of fishways have been designed, and have proved highly satisfactory for the alewife streams. No claim is made that these are the long sought universal fishways, or that they are suited for other species of fish. We know that they are successful for alewives, and that their simple type makes them well adapted to Massachusetts streams.

It was early realized that the main difficulty lay not in the fishway itself, but its adaptation to various prevailing conditions. Two distinct standard types which can be adapted to all ordinary dams have been designed.

The first type, *The David Fishway*, may be either of concrete or wood construction. With its sloping bottom and irregular baffles it resembles the Brackett type, but possesses the additional qualifications of frequent rest pockets, and a steady, uniform flow of water, which is controlled by the upper gate. Although more expensive than the second standard type, it can be advantageously installed in a limited space over an irregular course.

The second type, *The Straight Run Fishway*, is especially adapted for low dams where the contour of the stream bed affords a gradual fall. This primitive form of fishway more nearly resembles a natural swiftly broken stream, and possesses the advantage of stimulating the rapid ascent of the alewives.

Dam owners are required by law, when requested by the Fish and Game Commission, which furnishes complete plans and specifications for every fishway, to install suitable fishways at their own expense, and keep them open at specified times, under penalty of a fine of $50.00 per day for non-compliance. In spite of the difficulty in obtaining the willing co-operation of the dam owners,

who naturally object to the expense of construction, the work of installing fishways is steadily progressing, and it is hoped that soon all the potentially productive streams will be completely equipped.

POLLUTION.

With the continuous growth of towns and cities, unless better methods of disposal are devised and more stringent regulations enforced, the amount of water pollution is inevitably bound to increase. The alewife streams form part of this general problem, and similar methods of treatment are necessary. The pollution question is so important, difficult and complex in its inevitable conflict with large manufacturing interests, that to dismiss it in the few words necessitated by the limited scope of this paper seems most inadequate.

Sewage, except in the larger rivers, is of relatively less importance than the trade wastes, which comprise acids, alkalies and miscellaneous chemicals from nail and iron works, rubber factories, wool scouring establishments, bleacheries, laundries, dye works, leather factories, etc.

The following plan of approaching the pollution problem has been observed. All cases of pollution on alewife streams have been recorded and brought to the attention of the owners. Educational propaganda is under way, but as yet no effort has been made to use extreme legal measures.

(1) EDUCATION.—The evil effects of pollution are presented to the public by lectures and newspaper articles.

(2) SURVEY.—Every source of pollution is recorded, and the co-operation of the owner in its removal requested.

(3) DISPOSAL OF WASTE.—Through the expert advice of the State Board of Health, satisfactory means of waste disposal at the least possible expense to the manufacturers are recommended.

(4) UTILIZATION OF WASTE.—The manufacturers are shown how they can utilize their waste products to best advantage, and thereby cut down or completely eliminate the expense of maintaining a disposal system.

(5) LEGAL ACTION.—As an extreme measure, if the owner refuses to co-operate, legal action for the elimination of pollution, as provided under the present laws, may be instituted.

STOCKING METHODS.

All stocking methods are based upon the "Parent Stream Theory," which presupposes that the young alewives return as mature fish to the same waters where they were born. Depleted streams can be restored and new fisheries created by stocking, through the introduction of young alewives into the headwaters, which may be accomplished in two ways:

(1) Transplanting mature, ripe alewives to the spawning ponds.

(2) Planting artificially hatched fry.

Mature Alewives.—The yield of certain depleted streams has been greatly increased by transplanting into their headwaters spawning alewives from productive streams. It is sure, practical, and at the present time the only certain step for restocking unobstructed streams. It possesses the great objection of expense in catching and transporting the adult fish. Possibly small alewives could be seined in the late summer and similarly transported at a less cost.

Artificial Hatching.—The ideal method of propagation would be to plant artificially hatched alewives. Sufficient preliminary work has been carried out along this line to indicate that commercial hatching is feasible.

(1) *Ripe Fish.*—The principal obstacle is obtaining ripe fish for stripping. It is impracticable to obtain the fish in their journey up stream, since the ratio of males to females is large, and practically all the eggs are "green" at this time.

Seining the fish on the spawning grounds seems the logical method, unless the alewives can be held in pockets on their journey up stream until the eggs ripen. The ratio of male and female necessitates handling large numbers of superfluous males, as well as many unripe females. However, a sufficient quantity of eggs may be secured for the work with labor and patience.

(2) *Hatching.*—When seined the fish are stripped in the usual method. After fertilization, owing to their adherent nature, the eggs will mass together, but this may be obviated by constant stirring and by changing the water every five minutes until they harden. When first placed in open MacDonald hatching jars, the eggs tend to adhere to each other, but later they separate, becoming firm, hard and a light coffee color. The fry which have the appear-

ance of fine transparent threads attached to a relatively large yolk sac, can be held only for a short time in tanks before planting.

(3) *Planting.*—The advantage of artificial hatching over natural spawning is the protection of the eggs from the inroads of suckers, white and yellow perch, which frequent the spawning grounds. For protection from these fish, the fry should be liberated over a wide territory.

In spite of the great difficulty in obtaining the ripe fish, the artificial hatching of alewives is a practical procedure, but the beneficial effects of planting the fry cannot be demonstrated for several years.

REGULATION OF FISHERY.

The third important step in preserving the fishery is the proper legal regulation which will allow cultural and protective measures to achieve the best results. In place of the present voluminous special legislation for the alewife streams of Massachusetts, a few simple, readily enforced general laws, capable of local modification, should prove of great benefit in developing the alewife fishery.

Control.—The best method of operating the fishery would be a central board of control, with local representation, which would have adequate powers to enforce the laws, delegate authority and regulate each individual fishery in the interests of the whole. Thus each fishery would be freed from local disputes and irresponsible manipulation.

Lease.—The fishery should be leased to private individuals. A long term lease, not less than five years, is necessary, since the short term lease places a premium upon exploitation. The longer period will encourage a purchaser to safeguard the fishery in all ways.

Closed Seasons.—Closed seasons are beneficial only when they are used to supplement and protect constructive cultural work. A closed season is of direct benefit to the alewife fishery when the alewives are given a chance to spawn in large numbers, thus supplying a natural means of stocking. In all cases of depletion at least a three year period should be exacted, and the necessity of a further closed season determined by the results obtained, especially in cases where stocking operations have been simultaneously

carried on. In fairly prosperous fisheries, the one year closed season alternating with the five year lease should prove a good prophylactic measure for insuring the welfare of the fishery.

Season.—The length of the season should be the same throughout the state, and not exceed a maximum of 60 days. The exact dates for the commencement of fishing should be determined for each individual stream.

Fishing Days.—The time of catching should not exceed three consecutive days per week. Any combination may be selected, but the period from sunrise Tuesday to sunset Thursday is recommended as giving the best opportunity for preparing and disposing of the catch.

Fishing Places.—To insure easy enforcement of the law fishing should be conducted at definite places. Suitable equipment in the form of buildings, catching basins, etc., should be provided at these carefully selected places. Only in exceptional instances should more than one catching place be allowed per town, viz., seining privileges on the larger rivers.

Methods of Capture.—The methods of fishing should be clearly and definitely stated. The length and size of mesh for seines should be regulated.

Uniform Sale.—The method of conducting the sale of the alewife fishery leases should be uniform as regards time of sale, submitting of bids, awarding of contracts, payment, forfeiture and all other provisions.

SUMMARY.

The following points have been considered in this paper:

(1) The valuable alewife fishery in Massachusetts has declined because of unwise legislation, overfishing and obstructed streams.

(2) A study of the life history and habits of the alewife has indicated the proper methods of checking this decline.

(3) Experimental constructive work in providing unobstructed passageways to the spawning grounds, and in restocking depleted streams, has so far given excellent results.

(4) A satisfactory type of fishway for alewives has been designed.

(5) Depleted streams can be restocked and new fisheries developed by transplanting spawning alewives.

(6) Alewives can be successfully hatched artificially.

(7) Efficient laws are necessary for the proper uniform regulation of the fishery.

Discussion.

MR. JOHN W. TITCOMB, of New York, asked the following questions: What is the ratio of males to females during the run? At what temperature does the alewife spawn? What is the height of the highest successful dam, and how is the current directed so as to attract the fish to the fishery? Does each town make its own laws to regulate the fishery of its own district, and do you expect the towns to conform to any uniform rule?

MR. BELDING replied as follows: You will see one female followed by six or seven males. In seining, one time, I took only two females in a hundred fish. The fish we took spawning were in water at 72 degrees F., but we did not begin in time for the first part of the run. The highest dam provided with a fishway in successful operation is about fifteen feet and the breadth of the stream in this case is about 60 feet. There is no arrangement for directing the current at this dam. At other places we have used gratings during the run, which were hauled up when not needed. These gratings or screens extend across the stream. Each town regulates its own fishery entirely as it sees fit and the only check the state has on it is, that after the town has once established an alewife fishery it must keep it up and not allow it to deteriorate. It will be a very hard fight to get the towns to conform, but I think it can be done in some way in which each town will have the oversight of its own particular fishery, yet will be controlled by uniform laws that will be amenable to local adaptation. The minute we try to establish any system by which the Fish and Game Commission will take over the control of the fishery, there will be opposition in the town.

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THE RETAIL FISH MARKET: SOME SUGGESTIONS FOR EQUIPPING AND CONDUCTING IT.

By Arthur Orr,
U. S. Bureau of Fisheries.

The following paper has been prepared from observations made and data secured by the writer in extensive travels made during the past two or three years as an employe of the United States Bureau of Fisheries. The writer has had no experience in the fish business and hence, in this paper, presents only what he has observed and what has been told to him by men of actual experience. He has had the benefit of the criticisms and suggestions of several fish dealers of national repute, to whom a rough draft of the paper was presented. He believes there is a vital need for a publication on this subject, and hopes that someday some one who is much better qualified than himself will prepare a paper which will more adequately meet the needs of the situation.

At first blush it might seem that the methods of displaying and vending fish in retail shops do not affect the fishermen. But when it is recalled that the fisherman's prosperity depends wholly upon the purchases of the individual consumer and that the amount of fish purchased by the consumer depends wholly upon the character of the appeal which is made to him by the retailer and the satisfaction which he experiences from his purchase, it will readily be seen that the retail market is a very vital factor in the commercial fisheries. Hundreds of people are attracted to fish markets by pleasing window displays, purchase fish which have been properly cared for by the dealer and which are delivered to them in good condition, take them home and enjoy them, and return to the shop again and again to purchase more. Thousands of others, not so fortunately situated, buy fish from careless dealers who have kept the fish in unsanitary receptacles or who have been too saving of ice and thus give their customers

fish which have begun to go bad. These people do not return to make another purchase. You often hear them saying: "I never care for fish," or, "Fish are all right if you eat them as soon as they come out of the water, but you never can get them fresh from the markets." It is regrettably true that, while the former class is numbered by hundreds, the latter is numbered by thousands. It is sincerely hoped that this paper contains suggestions which will enable the retailer to so equip and conduct his shop that his customers will be repeaters and not mere "oncers."

In the long journey which the fish must make from the fishermen's nets to the consumer's table, every step is vital and fraught with possibilities of disaster. It is easily possible, even in warm weather, to transport fish long distances and deliver them to retail customers in first class condition, but this requires intelligent co-operation on the part of every person through whose hands they pass. Not the least important link in the distributive chain is the retail dealer. He may easily nullify all the pains and skilful attention bestowed by the fishermen and shippers.

The tendency of fish to spoil is enhanced by the length of time they have been out of the water; consequently, it behooves the retailer to exercise special pains to keep them at the proper temperature. Immediately upon delivery, the package should be opened and examined. If the supply of ice in which they are packed is low, it should be promptly replenished. Remember, that ice is cheaper than fish. There should be alternate layers of finely-chopped ice and fish. The custom followed in shipping fish in barrels or boxes is to place several inches of chopped ice in the bottom of the receptacle, another layer in the center, and a final layer on top, there being three layers of ice and two layers of fish. The standard barrel shipment contains 200 pounds of fish, for which about 150 pounds of ice are required. The amount of ice is increased somewhat in extremely hot weather and may be materially decreased in northern latitudes in the winter.

One of the questions frequently asked by persons contemplating opening a fish market is, "How long will the fish keep on ice?" The length of time the fish will keep depends on many factors, some of which are frequently without the control of the dealer.

Some species of fish are inherently better keepers than others. Some have better shipping qualities, and these would naturally keep longer after reaching destination than those known as poor shippers. It should, of course, be patent to all that fish will keep much better in cold weather than in hot weather. Much depends also on the length of time elapsing between the taking of the fish from the fishermen's nets and their being packed in ice. Some fishermen carry ice in their boats and ice the fish as soon as they are taken from the water. Fish thus treated will keep much longer than fish which are not iced until brought ashore, frequently many hours after their capture.

The care exercised in icing and handling is also a controlling factor. Insufficient ice, improper distribution of ice in the package, neglect of re-icing the fish by express messengers while in transit, the dropping of huge chunks of ice on the fish, thus bruising them and hastening spoilage, all tend to reduce the length of time the fish will keep.

It will thus be seen that there are three factors governing the length of time fish will keep after delivery to the dealer over which the dealer not only has no control, but concerning which he has little or no knowledge. They are as follows:

1. Length of time between capture and icing.
2. Method of icing and handling until delivery to dealer.
3. Length of time between capture and delivery to dealer.

It would, therefore, be impracticable to set any definite limit of time by which the dealer could safely be governed. Under the average conditions of capture, icing, and delivery of fish, the dealer may reasonably expect to keep his stock for several days, in some cases perhaps a week, provided, of course, he has a proper receptacle for the keeping of the fish and observes the requirements of proper icing and handling. It must be borne in mind that everything depends upon the condition of the fish when delivered and that the longer they remain unsold, the more precarious becomes the position of the dealer.

It must not be presumed from the above that the retail fish business cannot safely be engaged in except by the highly intelligent and technically expert. There are many means by which the amateur can with little practice determine the condition of the

fish and form a reasonably accurate judgment as to the length of time they will keep. Some of these tests are outlined in detail in a report* presented to The Netherlands Association of Refrigeration and are here quoted:

GOOD FISH.

Skin is shiny.
Scales strongly adhere to the skin.
Eyes transparent and bulging.
Gills bright red.
Flesh elastic and firm, finger impressions do not remain.
Smells fresh also at the opened gills.
Mouth and gills closed.
Little or no slime on the skin.
Muscular stiffness has set in in a greater or less degree, when the fish is taken in the hand it bends accordingly little or much.
The fish sinks in water.
After a short time a fishy smell and slime on the back appear.

BAD FISH.

The skin is covered with slime and is spotty. Sunken eyes, cornea dull and untransparent, mouth usually open, gills open or easily opened.
Gills lose their fresh color and become yellow greyish brown.
Finger marks in the flesh remain.
Smell unpleasant, especially at the gills. Held on hand the fish curves over. Sometimes the belly is swollen and bluish, then the fish will float in water.
In rotting these phenomena increase, in particular, of course, the smell.

These signs of good or bad fish must not be taken too absolutely. They do not need to be present all at once or in a particular degree to demonstrate the goodness or badness. Sometimes one peculiarity in a marked degree is enough to condemn the fish.

The amateur dealer should carefully observe the condition of the fish when delivered and attempt to judge with the aid of these tests the length of time the fish will keep. He should carefully check his estimates against the actual results. As time proceeds he will learn what species of fish are the better keepers, and he will

* From "Notes on the Investigation of Preserving Fish by Artificial Cold," 1913, pp. 33-34, 38-39. The quotation is taken from a memorandum entitled, "Criteria for judging fish preserved by artificial cold," published by the United States Bureau of Fisheries.

learn to judge more and more accurately the true condition of the fish and the probable length of time they will keep. He will not, of course, endeavor to keep the fish the longest possible length of time, but will bear in mind the wisdom of disposing of his stock as promptly as possible, as losses from spoilage are bound to occur even with the most experienced dealers and under the most favorable circumstances.

The means employed in displaying the product for sale has an important bearing on the success of the effort to bring about a wider consumption of fish. Many unprogressive dealers make a practice of selling the fish from the package in which they were received. This is usually an unsightly barrel or box, repulsive to the view. Very frequently the package is one which has been used on previous occasions for the same purpose and has developed unsavory odors which by no means enhance the customer's desire to eat of its contents. Other dealers, after transferring the fish from the barrel to the display cases, neglect to remove the barrel, allowing it to remain in the salesroom to give off offensive odors, which drive away trade and help to make fish unpopular as a food.

Fortunately, these conditions do not obtain in markets operated by wide-awake dealers. Inspiring examples of clean shops, where the fish are kept in a fresh condition and displayed for sale in an attractive manner, may be observed in many cities both large and small. No extraordinary skill, involving secret processes, is required to bring about these desirable conditions. The ordinary rules of common sense, intelligently applied, will be a sufficient guide to success.

It should be remembered that, in every line of business, practically all sales are consummated through the purchaser's eye. In other words, most people buy "according to the looks." Consequently, the fish market and display cases should be kept spotlessly clean. To this end, dealers are rapidly adopting display cases made of white material, which are not only attractive in appearance, but are more likely to be kept clean and sanitary, as the least spot of dirt or discoloration on any part of the case shows glaringly and calls loudly and constantly for attention until removed by one of the attendants. All tendency to neglect or postpone the cleaning of the case is thus reduced to a minimum.

Various materials are suitable for the construction of the case. The general plan followed is an open-top, rectangular receptacle constructed with double walls with from one to three inches of cork board or similar material between the walls for insulating purposes, and a drain pipe in the bottom. The interior of the case should be lined with some non-porous, non-absorbent material, preferably white in color. No. 16 gauge iron, enameled and baked, has been found suitable for this purpose. However, plain galvanized sheet-iron painted white will give satisfaction. Many dealers employ white tile for both interior and exterior linings. Opalite glass is sometimes used for the exterior and makes an attractive looking display case, but wood will answer the purpose, especially if painted white. Ready made display cases constructed entirely of white enamel sheet iron with cork board insulation and mounted on casters so the case may be moved from one place to another may be obtained on the market. They are especially suited to the small dealer, as they are made in sizes of 100 pounds capacity and up. Some dealers use shallow cases, not more than eight inches in depth. A layer of chopped ice is put in the bottom and the fish placed on top. This arrangement implies that the main supply of fish is kept elsewhere, from which the display case is replenished as sales are made. Many cases, however, are 15 to 20 inches in depth. About 9 inches of chopped ice is first put in and the compartment then filled with fish. A thin layer of ice is spread over the top, except in cold weather, when none is required. The fish remain in the display case until all are sold, when the compartment is thoroughly cleaned, replenished with ice, and a new supply of fish put in. Glass covers, sliding or hinged, are essential to protect the fish from flies and dust. In cold weather, when these are not in evidence, it has been found practicable to remove the glass covers. Care should be exercised not to bruise the fish by rough handling or dropping large chunks of ice on them. The bruised portions of a fish are always the first to become soft and begin to spoil. Any damages of this character which the fish may have sustained in transit cannot, of course, be obviated by the dealer, but he can, by proper care, avoid further bruising.

Every precaution should be exercised to keep down offensive odors. The plumbing should be of perfect character, so that all

waste water will be quickly and thoroughly drained. If possible, the cleaning of the fish should be conducted in a separate room. If this is not practicable, the process should be screened from public view. The floor of the cleaning apartment should be of cement, as wooden floors absorb and hold fish odors, which become more and more offensive from day to day. The work tables in the cleaning room should be covered with zinc or some other non-absorbent metal. Small pieces of board may be supplied to the workmen on which to lay the fish while dressing them. These should be scrubbed clean at the close of each day, and occasionally scalded with boiling water. The floor of the room should be sloping, with a drain pipe at the lowest point. Each night, all waste should be removed from the tables, the floors thoroughly scrubbed with lye water and the drain pipe well flushed. One dealer spreads fresh saw dust on the floor of his market each morning and sprays it lightly with oil of sassafras, which he claims produces a faint but pleasing odor and is at the same time an effective de-odorant.

The dealer should make every effort to increase sales. Window displays attract many new customers. It is doubtful that there is any other form of merchandise with which so attractive a window display may be arranged. The writer has frequently observed fine window displays of fish and in every case there was always a large admiring crowd of people standing in front of the window. Printed or hand painted signs announcing the kinds of fish on sale, and the price, should be displayed on the counters or the walls of the shop. The dealer who does not employ signs is missing an advertising opportunity. Advertisers pay money for space on street cars. The space on the walls of a fish market is just as valuable in proportion to the number of people coming into the shop.

Many customers become accustomed to buying a certain kind of fish, as for example, halibut, red snapper, etc., and when these are scarce, will not buy any other kind. This is a fault which it lies within the power of the dealer to correct. He should carry the kinds of fish which are in season and which can be sold at a reasonable price and when the customer calls for a fish which is not in stock, he should endeavor to sell him one that is. Tactful suggestion on the part of the dealer can usually accomplish this

result. A very prominent dealer in a large city, in emphasizing this point to the writer, said: "There's no use letting your customers dictate to you what kind of fish you shall handle. Give them the kind of fish they ask for if you have them. If you haven't them in stock, it is your own fault if you can't persuade them to try something else." This dealer has been notably successful in carrying out his own doctrine, and has been the means of introducing many kinds of fish into his territory which were formerly little used there.

Another means of increasing sales is to dress the fish before delivery to the customer. This entails extra labor on the part of the dealer and necessitates a somewhat higher charge, but most people would rather pay the difference than assume the inconvenience of dressing the fish at home.

The above suggestions, while brief in character, are easily applied, and if carefully followed out by any intelligent person, should result in a fish market of a highly desirable type. The principles outlined are equally applicable by large and small dealers. A meat dealer or grocer desiring to handle only a few fish may construct or purchase a small case of one compartment, holding only 100 pounds of fish at a time. He may reasonably expect that the adoption of a display case attractive in appearance and capable of preserving the fish in a strictly fresh condition will materially increase his sales. As business grows, additional compartments can be added, the difference between the equipment of a small dealer and that of a large dealer being only one of size. There are many ready-made cases which give satisfactory service obtainable on the market, but any competent carpenter or builder can devise one from the suggestions outlined above.*

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* Addresses of firms selling fish display cases may be obtained from the U. S. Bureau of Fisheries, Washington, D. C.

LOUISIANA—GREATEST IN THE PRODUCTION OF SHRIMP—PENAEUS SETIFERUS.

By E. A. Tulian,
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According to the United States Census Report for the year 1908, the total shrimp production in the United States amounted to 14,374,000 pounds. Of these, Louisiana produced 8,580,000 pounds, or approximately 60% of the whole. This same report credited the Gulf Coast region with having furnished 12,561,500 pounds of the entire production. It will, therefore, be found that Louisiana contributed about 69% of the shrimp of that region in 1908.

From statistics collected by the United States Bureau of Fisheries for the year 1916, we learn that the entire catch of shrimp over the territory extending from the northern boundary of North Carolina to the western boundary of Texas, amounted to 43,942,105 pounds. Louisiana produced 23,160,586 pounds of this total, or about 53% of all. The Gulf Coast States alone produced 38,936,680 pounds, including those caught along the Atlantic Coast of Florida, and of this total, Louisiana produced 60%. If we were to eliminate Florida's catch on the Atlantic coast, Louisiana's catch would amount to approximately 85% of the entire Gulf Coast region.

Before going into further details, it might be well to give a brief comparison here of all other commercially available species of shrimp found in Louisiana waters. In the majority of species of shrimp, the female, after egg laying, carries its eggs attached to the swimmerets under the tail or abdomen until they are hatched. In Louisiana there is only one species of this group of egg-carrying shrimp which is sufficiently large to be consumed as food. This is the so-called river shrimp, *Mancrobrachium ohionensis,* a rather stout species, which, however, is only three inches long. This species inhabits the Mississippi River and other fresh water streams of Louisiana, where it is taken by means of baited traps, perhaps a hundred being caught in each trap under

favorable conditions. The supply, however, being rather limited, is consumed by local markets in the towns and cities along the river, where it is considered a great delicacy.

The so-called river shrimp and other egg-bearing shrimp of this region possess two pairs of chelate legs, and by this means can be easily distinguished from those shrimp which do not carry their eggs, as all of the latter possess three pairs of chelate legs. In this latter division of shrimp, the Penæidæ, the eggs are set free in the water and allowed to shift for themselves, where, after hatching, they pass through a larval transformation. In Louisiana there are three species of the Penæidæ, which are available as food and these are all salt water species. Two of these are *Penæus setiferus* and *Penæus braziliensis*, while the third, belonging to a closely related genus, is *Xiphopenæus kroyeri*.

Xiphopenæus kroyeri, a small slender shrimp, the adults of which average three and a half inches, can be easily recognized by its long recurved rostrum bearing six spines on its upper edge, and its long antennæ which are about three times the entire length of the animal. Another striking characteristic is that the last two pairs of walking legs are long and slender, the last especially being filamentous and nearly as long as the animal. This species, known on the Gulf Coast as the *Sea-bob*, appears to pass its entire life in the Gulf, and although it often approaches close to the beach, it seldom if ever enters inside waters. When the sea is rough they are found some distance off shore, but when calm they come in to the very beach itself, where they become at times a veritable pest, as fifty to ninety-five per cent of the catch, under some conditions, may consist entirely of this species. Due to their small size, the market value of the catch is considerably lower, and if lake shrimp are abundant and platforms loaded to capacity, these sea-bobs are refused and thousands of pounds must be thrown overboard dead. Because of their small size they are never marketed in their fresh state and the canning factories find it unprofitable to use them, yet if one takes the trouble to pick them, they are a fine dish because of their delicate flavor.

Aside from *Penæus setiferus*, which largely concerns this discussion, the one other species which we must consider here is the Brazilian prawn, *Penæus braziliensis*, a large species closely

resembling the former, with which it is sometimes associated. The antennæ of the Brazilian prawn are comparatively short, being less than twice the length of the animal, while in *Penæus setiferus* they are over twice the entire length. The rostrum in both species usually has nine spines on the upper edge, but in *Penæus braziliensis* it is bordered on either side by a groove where it keels the cephalothorax. This groove is absent in *Penæus setiferus*. *Penæus braziliensis* is also of a more greenish color, mimicking the greenish vegetation with which it is usually associated, while *Penæus setiferus* has a clearer "complexion," showing a preference for open waters which are bare of living vegetation.

Penæus braziliensis is not recognized by the fishermen as a distinct kind of shrimp and whatever small per cent is caught by them is marketed with the ordinary lake shrimp. They seem to make their appearance earlier, however, and in the month of June when the young lake shrimp have not appeared as yet on inside waters in appreciable numbers, catches of this species unmixed with any of the others are quite common. They are never as abundant as either the sea-bob or the lake shrimp, and consequently are almost negligible as a commercial proposition. Adult specimens of *Penæus braziliensis* have never been observed in Louisiana and nothing is known of its breeding habits.

The adults of *Penæus setiferus* average between six and eight inches, and the cephalo-thorax especially in the female is very large compared to that of immature specimens. In the ripe female the ovaries are very large and fill a considerable portion of the cephalo-thorax, extending down the back to the very tip of the abdomen.

That the Conservationists of Louisiana appreciate the value of the salt water shrimp resources of the State is evinced by the fact that as far back as 1906 a study of their life history and habits was commenced at the State Gulf Biologic Station, located at Cameron, Louisiana, and continued until the station was abandoned several years later.

A considerable amount of valuable information along the lines mentioned was obtained by H. M. Spaulding, M. S., Zoologist in charge of Experimental Work, Wm. H. Gates, and others. In December, 1912, the U. S. Commissioner of Fisheries wrote

our department that his Bureau had no publications regarding the life history and habits of the lake shrimp and further on added, "The Gulf Biological Station of Louisiana began a study of this subject, but it was never prosecuted very far, although some matter on the life history of the shrimp has been published in the report of the station."

This department long ago realized that a thorough investigation of the life history and habits of the species was necessary before it could determine its economic status, in order that intelligent measures of conservation might be adopted, so that the industry would not merely be preserved for posterity in its present state, but, if practicable, be made to increase so as to reach the greatest possible yield. In July, 1918, Commissioner Alexander instructed me to take up these studies and carry them forward as thoroughly and rapidly as possible; and to continue the same as long as necessary. In compliance with these instructions, we arranged for the use of a large power houseboat belonging to the U. S. Bureau of Fisheries and put her into commission with a crew consisting of a captain, engineer and cook. We engaged the services of Percy Viosca, Jr., M. S., formerly of the Department of Biology at Tulane University, to conduct the scientific investigations, and I myself devoted a good deal of time to it. We are still at this work and will likely continue for at least a year longer.

Studies were made of the physical and biological conditions of the waters in which shrimp were found and information was obtained as to the sizes and quantities taken at various times and localities under varying conditions. Statistics were compiled from the records of the various shrimp platforms and canning factories with a view to determining the past production of our waters, in order to learn something of the possibilities for the future of the industry.

Comparative studies were made of the different methods of fishing in order to determine how maximum production may be obtained with a minimum waste of this and other valuable sources of food supply. No attempt can be made here to go into the details of the investigation, but a brief outline will be given of the information gathered and the gratifying results obtained during the short space of time which has elapsed since the work was actively begun.

The southern prawn, *Penæus setiferus*, is usually known in Louisiana as the "lake shrimp." This name was derived from the fact that at certain seasons of the year they are abundant in all of our brackish waters, bays and lakes. The name, however, is a little misleading and we find that it can not truly be applied to the adults of the species, which on the Louisiana coast are confined solely to the waters of the Gulf. All specimens found in land-locked bays and lakes are now known to be immature specimens. Considering shrimp of commercial size, irrespective of sexual maturity, we might say that their habitat consists of all the salt and brackish water lakes, bays and bayous of our state, extending at times into some of our fresh water lakes where biological conditions are suited to their growth. Indications are that they may even be abundant far out from shore in unexplored regions of the Gulf.

The shrimp under consideration are the chief and most efficient scavengers of the open areas of our lake and sea bottoms, and in their search for food they are constantly moving about from place to place picking up all available particles of plant and animal matter. In the sea their food consists of the debris and remains of practically all forms of marine life, the higher as well as the lower forms, such as hydroids, bryozoa, worms, crustaceans and sea-weeds, etc. In the bays and lakes, surrounded by our salt marsh country, their food is composed largely of small pieces of the roots, stems, and leaves of the salt marsh grasses, which are constantly washed into these bodies of water by the waves and receding tides. As long as our salt marshes exist, there is little danger of their food supply running short, and in this respect our salt marshes are a valuable asset to the state.

Penæus setiferus is a migratory species, but its movements are often difficult to follow, being very erratic. Observations tend to show that they usually travel slowly along the bottom, feeding meanwhile as they crawl along by means of their walking legs and swimmerets. In places where their food is abundant, shrimp accumulate in large schools, muddying the water as they feed. Aside from attraction by food, another cause of their migrations appears to be the currents, which are caused by a complicated set of factors; the normal bayou or river current, the tides, and the winds, which latter is often the most important. Sometimes

they are compelled to travel rapidly and this is accomplished by means of the swimmerets alone.

The real secret of their movements, however, appears to lie in the changing salinity of the water and this probably affects the animals by its varying osmotic pressure. At any rate, shrimp seem by preference to remain in water of a more or less constant salinity, or at least do not desire sudden changes and their migrations into water of a different density is evidently comparatively slow. With very young shrimp there is a slow gradual migration inland and as these immature shrimp approach maturity there is a second gradual migration, this time back towards the sea, where they return when they reach the sexual stage and where they appear to remain for their entire adult life.

The breeding season does not seem to be a short one and varies with the individual shrimp, apparently being extended over a considerable period which covers at least the spring, summer and early fall months. As our work was handicapped last winter during the influenza epidemic, it will take further observations to determine the entire extent of the breeding period and the per cent of individuals spawning throughout the various seasons. This more or less extended breeding period is sufficient to account for specimens of all sizes being found over a considerable portion of the year. Because of the difficulty of keeping adult specimens in captivity, no observations have as yet been made upon the spawning habits of this species. There is no doubt that in Louisiana this is confined entirely to the waters of the Gulf itself. Although considerable effort is being devoted to the study of the early stages in the development of the shrimp, little as yet can be said on the subject. Of the myriads of eggs laid, the large majority must no doubt perish before they assume the adult form, minus, of course, the sexual characteristics. At this time they are about an inch long and from now on their history is more easily traced, as they have now made their way into inside waters and are abundant along the shores of lakes, bays and bayous, and especially in shallow lagoons near the coast where they feed in the ooze which rests upon the alluvial clay mud bottoms which are bare of vegetation. Here they appear to grow very rapidly and begin their slow general migration. This migration seems to be in reality a gradual spread over all waters

in which conditions are suited to their growth. By watching the growth of the maximum-size specimens, of this so-called summer crop, we have gained some idea of the rate of growth, or at least know something of its order of magnitude. This seems to average somewhere between one half and one inch per month and as the smallest adult shrimp are six inches in length, it would take somewhere between six and twelve months for a shrimp to grow to maturity; (the latest observations point to the former period). The young shrimp found in the shallow waters near the sea coast in the early summer, spread in all directions and by the end of September specimens are found far inland, even in fresh water lakes. All this time they have been growing and, as they do so, they seek the deeper waters, being replaced gradually in the shallow places by successive crops of younger specimens. At this time, that is, during the fall, the migration of the largest specimens back towards the sea begins to take place, while other small shrimp are continuing to make their way inland.

We must at all times keep one thing in mind, however, that shrimp are greatly affected by weather conditions and changing currents and this general migration is often obscured by many complications. In the winter months especially, conditions are much changed and the growing shrimp cannot advance as far inland, perhaps partly, because of the cold and partly because of the currents caused by the winter rains, there is a change in the physical and biological conditions of the inside waters.

Although (owing to the influenza epidemic) our observations during the winter months are rather incomplete, nevertheless there appears to be a period during the coldest part of the year when either no eggs are laid or; at any rate, we are sure that no young make their appearance in our inside waters, as by the end of February it is rare that we find any shrimp anywhere under two and a half inches. By watching the growth during the spring months, of these minimum-sized specimens, we can arrive at an estimate of the approximate rate of growth. This corresponds closely to the figure obtained for the summer growth. By the middle of May the smallest shrimp had already grown to five inches and the new crop had made its first appearance, the largest specimens of which were already two inches. It is a significant fact that, in spite of the immense amount of material examined

at this time from every variety of conditions, no shrimp could be obtained anywhere during the month of May that were between the sizes of 2½ and 5 inches. From May on we had two series of figures to guide us, the minimum sizes of the old crop and the maximum sizes of the young crop. By June all shrimp of the old crop had disappeared from inside waters as they assumed the adult form at a general average of six inches for minimum sized specimens. Far out from shore in the Gulf adults of eight inches and over are not uncommon. At this season, that is early summer, it is absolutely impossible to obtain any shrimp of commercial size in the inside waters. The new crop is as yet confined to shallow water near the coast and specimens are as yet too small to be taken in quantities by the general methods used by the fishermen.

In the early days of the fishing industry of Louisiana it was learned that, because of the fact that shrimp are gregarious, accumulating at times in very large schools, the most profitable method of taking them was by means of seines. As the size of the catch over a long period was in direct proportion to the size of the seine, large seines became very common and some were as long as two thousand feet. In the early days of the shrimp industry the seine crews went out in large row-boats equipped with sails in case of favorable winds, and for large seines a crew of twenty men was not uncommon. These boats searched the bottoms of the various lakes and bays, locating the shrimp by means of small cast-nets, and when a school was found, the size and extent could easily be determined by the fishermen. The seine was then laid out and, if it were possible, the entire school would be surrounded and taken, only a negligible per cent escaping. The shrimp were then separated from the balance of the catch, which was considered worthless and practically all fish, crabs, etc., were thrown overboard whether of food value or not, as it was unprofitable to market them at that time. The shrimp were then mostly taken to the drying platforms and a small per cent iced and taken in their fresh state to the New Orleans markets.

With the advent of the gasoline launch, shrimp were more easily and quickly located and more extensive was the territory covered; the shrimp industry growing by leaps and bounds, canning factories were established, while, at the same time, there was a proportionate increase in the wasteful and destructive

practices of the fishermen. Since the food shortage caused by the war, it has now become profitable to dispose of all fish of a marketable size; but it is still impossible to rescue the millions of young food and other fishes caught in the shrimp seines, as the majority seem destined to die even if rescued, probably because of the secretions given off by the shrimp. The ordinary way to clean the catch is to dump the entire lot in the boats and throw out the dead fish and trash by hand and with the aid of small rakes. If the catch is considerable, the process requires some time, whereas even the more hardy fish are dead in a few minutes.

During the year 1917 a new method of catching shrimp appeared in the field, the shrimp trawl, a netted device which is dragged on the bottom behind a gasoline boat. This consists of a large bag similar to the pocket of a seine, with short wings attached to heavy weighted boards on either side. These boards are tied to the boat by long ropes and are bridled in such a manner that the device is kept at the bottom and opened to its fullest extent while operating. A comparative study is at present being made in order to determine the relative values of the seines and trawls. We find in the first place that trawling brings greater revenue to the fishermen as the average catch per man per day is considerably increased. This proved a great blessing during the war, while the shortage of labor was acute, as one or two men could often take the place of fifteen or twenty. From four trawls in 1917, the number has gradually increased until at the present time there are approximately two hundred and fifty operating in Louisiana waters, while the number of seines has somewhat diminished.

With the trawl, the waste of valuable food fish life has been reduced to a negligible factor, as a trawl seldom catches an appreciable amount of fish; whereas the destruction in the case of the seine is so great that it appears to be the main cause of the rapidly diminishing supply of Louisiana salt water food fishes. Furthermore, up to the advent of the trawl, the adult of *Penæus setiferus* was unknown as a commercial proposition, as they seldom come within seining distance of the shore. On the other hand, from a depth of one fathom to as great a depth in the Gulf as has ever been tried (about ten fathoms and a distance off shore of about eighteen miles), there has been opened by the trawl an

immense fishing ground, where a bounteous supply of adult shrimp always exist with almost endless possibilities for the future of the shrimp industry. The disadvantages of the trawl must not be overlooked, however, for at certain seasons of the year when small shrimp are abundant in inside waters, and when they are traveling through the bayous, they can be destroyed in considerable quantities by selfish fishermen. This fault however is not inherent in the device itself as shrimp show a natural tendency to separate themselves into schools of uniform sized individuals, and when seines and trawls operate side by side the average size of the shrimp caught is always identically the same.

As mentioned before, the Department of Conservation of Louisiana is making a thorough investigation of the situation with a view to correcting all wasteful practices by proper legislation and the time is coming when the shrimp industry will expand as it never has before, in such a way that the maximum yield possible will always be produced annually and yet be preserved in that state for all time to come.

WHY DO SALMON ASCEND FROM THE SEA?

Prof. Edward E. Prince,
Dominion Commissioner of Fisheries,
Ottawa, Canada.

Salmon problems are perennial and their solution, by the sportsman, the fishery expert and the man in the street, appears to be as distant as though not a word had been said, or a single hypothesis offered. "Do salmon feed in fresh water?" "Do salmon die after spawning?" "Do salmon spawn annually, biennially, or when?" "Why do salmon ascend from the sea?" These are amongst the multitude of perplexing questions which seem to evade solution, and form the subjects of controversy as keen today as in the days of Humphrey Davy and Izaac Walton.

I shall attempt to deal with the last question, because some recent researches into the chemistry and physiography of the sea appear to afford light which has long been sought in vain.

Is Salinity a Cause?

Professor Joly's well known views on the saltness of the sea in past ages and at the present epoch, are of absorbing interest. To most people their chief importance, perhaps, lies in the answer they offer to the query, "How old is our earth?" But whether the earth be ninety millions of years old, as Joly declares, or be vastly older, the point of interest, so far as "salmon questions" are concerned, lies in his very plausible contention that as the sodium contents of the earth's rocky crust is decreasing, owing to the continual wasting and wearing process, physical and chemical, which are going on, the rivers of the world as a whole are bringing down less sodium now than in past ages, and this decrease in the amounts dissolved in the down-flowing streams, affords an explanation of the salmon's migration.* If the salmon, living

* Professor W. G. Bulman has pointed out that past and present marine faunas show not a general increase in the sea's salinity, but a decrease, for the Mollusks, Brachiopods, Cephalopods, Pteropods, and other exclusively marine Orders have diminished down to our own epoch. (Sci. Progress, April, 1917).

during the first year or two of its life, in river water, finds it too fresh for its comfort and welfare, then the only alternative is to descend to the sea and seek a more favorable saline environment. The effect of fresh-water surroundings on salmon migrating from the sea is undeniable. From the moment that it leaves salt-water the adult salmon loses condition and deteriorates. Fresh water seems to be most unfavorable, it loses its appetite, it becomes emaciated, weak and diseased, and its only hope of recovery is to return, it may be after many weeks or many months, to the sea. If the sea salmon remains too long in fresh-water it dies miserably, and that indeed is the fate of whole schools of Pacific salmon, all perishing, and none, it is claimed, ever again reaching the sea. Whether there are exceptions is a moot question, and I have dealt with it in a special report on the Life History of Canadian Salmon. (Marine and Fisheries Report, Ottawa, 1908, pages 38-40).

A fresh-run salmon is the prize most eagerly sought by the sportsman. Its vigor and muscular strength, its keen alertness and activity, its fighting and swimming powers, even its firmness and flavor on the table, are all at their best. The commercial firms who handle salmon, fresh, cured, or preserved, in cans, recognize the superiority of salmon fresh from salt-water. A few months in fresh water suffice to transform it, and it loses its brightness, its alertness and vivacity, even its perfect shape, and it becomes a thin, lank, unclean fish; a "slink salmon;" a "kelt;" a black salmon, often covered with woolly fungus and disfigured by wounds and deformities. Salt water is evidently normal for the adult salmon; but it cannot be the stimulating cause for forsaking the sea and ascending into abnormal and unfavorable fresh-water conditions.

Importance of Temperature.

That temperature is a potent factor in encouraging or deterring the ascent of salmon has been always admitted. If the fresh water pouring into an estuary be too cold or too warm, if owing to a dry season or light snowfall there is a paucity of water, the schools of waiting salmon lingering near a river mouth, will remain for a few days, or it may be several weeks before ascending. They are said to be acclimatizing themselves to the new fresh-water conditions facing them. With an abundant down-rush of cool

floods the salmon become impatient to hasten up-stream and in a few weeks, in some cases a few days, they reach the breeding areas and carry out the important processes of spawning. Often ten to fifteen days suffices for the ascent; but in the giant rivers of the Pacific Coast many months are occupied in the migration to the head waters. Species such as the dog-salmon (*Oncorhynchus keta* Walbaum) and hump-back (*Oncorhynchus gorbuscha* Walb.) enter the rivers in a very advanced and ripe condition, and many spawn within a very short time in creeks, and small streams only a little distance from the mouth; but the spring salmon, or King, or Quinnat salmon, and the Blue-back or Sockeye salmon do not reach their spawning grounds, in many cases, for several months. The early Sockeye schools of the Fraser River, British Columbia, entering from the sea, late in June or in July, do not reach such waters as the Quesnelle, or Stuart's Lake or Fraser Lake until late in August or early in September, the arduous journey occupying eight or ten weeks; but in the case of the Quinnat or King salmon ascending the Yukon River (2000 miles long) the fish take five or six months to reach the upper waters and winter has set in before the main schools arrive at Dawson, where they are eagerly captured for food purposes, in spite of their unfavorable condition, after 1200 or 1500 miles ascent.

Salmon, a Marine Type.

Authorities are divided in their opinion as to the marine or fresh-water character of the salmon. The determined persistence with which the schools of salmon work their way up their native rivers, no obstacles, rushing rapids, precipitous cascades, almost impassable falls, or other barriers, being sufficient to deter them, has been taken as evidence of fresh-water origin. Why should they make such extraordinary efforts to get far from salt-water, if the sea is their natural habitat? Moreover, salt-water is fatal to the eggs and to the young stages, as Professor McIntosh, of St. Andrews, Scotland, proved fifty years ago, for the yolk acquires the consistency of dense Indian-rubber, and later if preserved in alcohol, assumes a corky character, while the early maturer fish in the advanced "parr" and "smolt" stages require slow and gradual acclimatization to sea-water in their descent from the upper fresh-water pools to the ocean. In adult life the change from

the sea to the river conditions or *vice versa* is never a sudden, but always a gradual process. Sir Herbert Maxwell, Professor Noel Paton, and other well-known writers on Salmon are convinced that they are fresh-water fish, an opinion apparently that also of Mr. Henry Lamond in his fine work on "The Sea Trout," for in his critical remarks on the view of Mr. Tate Regan (of the British Museum) that the Salmonidæ "may be regarded as marine fishes establishing themselves in fresh water," he says, "the facts equally point to fresh water as the original habitat of the Salmonidæ. In particular, the fact that in salt water the spawn of Salmon and trout cannot come to fruition seems to me to be pertinent." My own conclusion long ago was that the Salmonidæ are marine forms, and the feeding habits and the rigid fasting of adult salmon in fresh water strongly support my view, while the adaptation of the eggs and of the young and immature stages to fresh water conditions can be readily explained. If the Salmon be a native of the ocean, and the fresh water habitat only resorted to for special reasons, how is the remarkable transformation to be accounted for? The evolution of the whales and seals from land forms to aquatic types is hardly more striking and remarkable.

Does Migration Avoid Sea Dangers.

Professor L. C. Miall, thirty years ago, hazarded the opinion that salmon resorted to the upper portions of rivers, more or less distant from the ocean, in order that the dangers of the sea-bottom, especially predacious enemies, might be avoided. The eggs and young, it was argued, would be safer in fresh water streams. The force of this contention never appeared to me to be very convincing. Of course the eggs and young of very few fish are found on the sea-bottom. The physical and chemical conditions, the darkness, the pressure, the cold, and especially lack of oxygen, are all unfavorable, and most marine fishes appear to deposit floating eggs, or resort to the shallow waters, close inshore, or even between tide-marks; for in the surface waters, and in the littoral shallows, the necessary conditions for hatching and larval development are best provided, and wind and wave action ensures, as is well known, the richest condensation from the atmosphere.

Oxygen, Light, Warmth, etc., Required.

To an active and vigorous fish such as the salmon, the favorable conditions referred to are essential at all stages. "A desire for freshly aerated water," writes a recent authority, "may stir the salmon to ascend swift down-floating streams, as oxygen is needed for the spawn." But a down-floating stream is not sufficient; shallow, clean, gravelly rapids are necessary, and it is impossible to imagine that the salmon consciously recognizes anything of these necessary conditions. "Salmon do not spawn in deep water anywhere," declared John Mowat, who knew more about the Scottish and East Canadian salmon, as a practical man, than any other unscientific observer, after his experience in early life on the famous Scottish Dee, and for over forty years on the finest of the world's salmon rivers, the peerless Restigouche. "They may nest on high gravel bars and beaches," he added, "and these may be covered with ice in winter."* Indeed, I have myself seen cakes of ice floating down the Restigouche in spring streaked with red layers of salmon eggs, deposited blindly by the parent fish in the preceding fall. Of course, the body of water pouring into the sea out of the mouth of a salmon river, is usually cold and well aerated, for it has hurried down many rapids, bounded over many falls, and swirled round endless eddies, and must carry a maximum quantity of dissolved air, but its coldness increases its power of absorption of air and of oxygen, though there are limits to such absorption. As the temperature rises absorption decreases. Thus one volume of fresh water at 0° F. dissolves 0.049 of oyxgen, i. e., about one-twentieth of its volume; but at 20° F. it absorbs only about two-thirds of that amount, i. e., 0.031 or about one-thirtieth of its volume; 475 litres of water will absorb 32 gms. of oxygen at zero Fahrenheit, but if the water is saturated with dissolved air, about 23 gms. of oxygen will be contained in 23 cubic metres of water. Professor T. Clowes, in his evidence before the London Sewage Commission, in England, in 1904 (Vol. II, p. 115) said that he had found fish able to live in water of 50% of the maximum aeration; but they could survive in 30%. Professor Roule, as is well known, explains the migration of salmon

* Chaleur Bay and its Products, by John Mowat, Chatham, N. B., 1888.

by the impulse to seek water richer in oxygen, but such must be a subordinate factor for salmon may pass several seasons continuously in the sea.

Salmon Rarely Captured at Sea.

The migration of Salmon presents many facts which impress the scientist as profoundly as the ordinary observer. The sea at various depths is ransacked by man's engines of destruction, and the feeding resorts of the salmon are probably at considerable depths, or the fish would be taken more frequently than they are, in nets and on hooks, used on a vast scale by hundreds of thousands of sea fishermen. Occasionally a salmon is taken in the ocean, but such captures are rare, even in an area like the Gulf of St. Lawrence, into which empty between 50 and 60 famous salmon rivers.

Apparently the vast schools of salmon, which scatter in the ocean after leaving the rivers of this continent, and of northern Europe and Asia, descend beyond the reach of the gear so plentifully strewn over every sea, and elude the observation of scientists and of all who fare upon the deep.

Temperature Extremes Deter Ascent.

Salmon migrate into fresh water at regular seasons of the year, indeed, a leading canner in British Columbia finds, from a record kept for a great number of years, that the date is almost uniform, varying only a day or two from year to year for the main "July run" of Sockeyes. On reaching the estuary, Salmon often linger as if to accustom themselves to brackish and fresh water conditions. A temperature too cold, or too warm, a dry season with low water in the river may detain them, but with the descent of an abundant flood of cool water, due to rains or melting snow, the salmon schools cannot be restrained.

Time and Length of Ascent.

Once fairly in the river nothing can daunt them. The ascent may cover many weeks or even months, the early runs in May or June will linger longer on the way than the latter schools in August, September, or October, while, in some Pacific rivers, Salmon which ascend in November and December migrate most rapidly of all. Ten, fifteen, or twenty days, may suffice; but such species as the

hump-back and dog salmon of the Pacific coast may be on the spawning grounds within twenty-four hours, such grounds being creeks and shallow streams, or other areas, frequently a very short distance from salt-water.

The earliest schools of Fraser River Sockeyes entering in June, were found to arrive in the upper waters, the tributaries of the Fraser, Stuart, Quesnelle, and other lakes, late in August or early in September, thus occupying eight or ten weeks in the ascent, while in the giant Yukon river, the spring salmon or Quinnat, usually called King Salmon at Dawson, takes five or six months in ascending the 1200 miles necessary to be traversed in the migration from the estuary to the upper waters in the Yukon Territory. These Yukon fish must travel at the rate of ten miles per day, though some of the ascent is accomplished by spurts. Livingston Stone estimated the rate in the Sacramento river at two miles per day, and in the Columbia river at three miles per day; but some observations on Atlantic salmon indicate a greater speed. The claim that a salmon may cover forty miles of ascent in a day does not seem to be usually confirmed, though John Mowat wrote nearly forty years ago: "I have taken two salmon thirty miles up the Restigouche with undigested caplin in their stomachs. These caplin must have been seized thirty miles below the head of tide as caplin will not enter brackish water. * * * I have an idea," Mr. Mowat added, "that these Salmon were not more then twelve hours running up this sixty miles."

Salmon Overcome Grave Obstacles.

As I have watched, during many seasons, the hordes beyond computation of Sockeye salmon passing up the Fraser river, the Skeena, the Naas, Rivers Inlet, and other well-known British Columbia rivers, I have often asked myself why it was that the fish did not choose some nearer and more readily accessible spawning grounds. There are numberless suitable areas within 30, 50, or 100 miles; why should the salmon make long journeys of 300, 500, or more miles, in order to reach the tributaries of Quesnelle, or Fraser, or Stuart, or Oweekayno (Rivers Inlet), or Babine (Skeena river) Lakes. Every mile presents new perils; and frightful canyons, rapids, like torrents; falls that involve tremendous leaping efforts; and groups of marauding bears waiting along

the sandy shallows; Indians dipping their long nets or erecting wickerwork barriers; fish-hawks and eagles all taking toll, combine to make the ascent little less than a progress of decimation. No one who has gazed into the foaming canyons of the Fraser or Skeena rivers, 250 to 450 miles long; or canoed down the Oweekayno river over four miles of furious torrent, or seen such terrifying spectacles as the "Skookum Chuck" on the Lilloet river below Tenas Lake, can fail to be amazed at the power of the impulse which drives the fish through all these perils, and brings the survivors at last to the pools and rippling shallows of the distant spawning streams. These survivors show convincing evidence of the dread ascent, for their bodies are torn by rough stones, gashed by jutting rocks, maimed by jagged and precipitous obstacles, or by falling, time after time, down almost impassable falls. With fins and tails worn off or torn away, with jaws broken, eyes missing, and with sides showing sores and fungused wounds, they bear every evidence of incredible difficulties and disasters, encountered on the laborious journey from the mouth of the river. None of the usual explanations appear sufficient to account for this irrepressible desire to reach remote waters, when lower creeks and tributaries invite the salmon to enter. The fish pass these, though they may appear ideal for the purpose sought, just as an ordinary citizen passes a hundred other people's doors in order to reach his own more distant door.

Comparison With Bird Migration.

The migrations of salmon and of birds have often been compared. The annual flights of birds may extend over lands, seas, deserts, and mountain ranges, and may even extend from one hemisphere to another. Why, for example, do the vast flocks of Godwit (*Limosa uropygialis*) go annually from beautiful New Zealand to bleak and uninviting Siberia? The marvel about the salmon's migration is this, that birds have keen sight and powers of topographical recognition, but such acute vision and memory cannot apply in the case of fish. Were the salmon able to remember the physical features of its native river mouth, the outflowing current is so often beclouded with mud, and the contour of banks and weed-covered rocks must change constantly, so that submerged landmarks must be unreliable. Professor Arthur Thomson

says of the migratory courses of birds that they are "sustained by tradition," but Pacific salmon die yearly after the first visit to the spawning grounds, and cannot hand on any such tradition.*

Instinct Affords no Explanation.

To speak of instinct is to beg the question. Instinct by its very nature is regarded as infallible; as certain and unfailing as the law of gravitation or of chemical combination; but salmon are not unerring in their movements. Sometimes a fish makes its way into the wrong river. Restigouche salmon have occurred, though very rarely, in the Miramichi river, New Brunswick, and *vice versa*. The Miramichi salmon reach ten or twelve pounds weight usually, and have a build and contour quite characteristic; but the Restigouche salmon commonly weigh twenty pounds or more. (John Mowat, p. 10).

After the planting of Restigouche salmon fry in the Nepisquit river, Mr. De Wolfe Spurr, a well-known angler from St. John, N. B., identified the introduced fish when they reached maturity, and another experienced angler, Colonel Walker, identified Gaspe salmon after these had been planted in the Grand river. (John Mowat, p. 10). Had the Atlantic salmon, planted in New Zealand, proved a complete success, the unerring character of their migratory powers would have been established—but this stocking of Antipodean waters with *Salmo salar* has been really a failure. Various causes have been suggested, such as lack of suitable food in the sea, or unfavorable conditions of salinity and temperature. But these causes do not apply. I can vouch for the abundance of suitable food, for I have surveyed pretty completely, the inshore and offshore sea-bottoms of New Zealand. Trout of various kinds, Rainbow, English brown, Loch Lomond, etc., have been a marked success. The explanation may be that trout are more restricted in their wanderings in the sea, and find their way back; but the salmon may resort to considerable depths, far from the estuary of the river in which they were hatched, and instead of finding their way back, they wander aimlessly, and perish in the vast expanses of the South Pacific and Tasman seas.

* "The Study of Animal Life," by J. Arthur Thomson. Murray, London, 1892.

Salmon are True to Native Rivers.

I think that I am one of the few students of salmon life who has never wavered in his view that Salmon are true to their native rivers. Many eminent authorities firmly held the opposite view, others held the opposite view but have been converted, and the tendency now is to adopt the opinion which I have always expounded and firmly held. My eminent friend and former international colleague, Dr. David Starr Jordan, has consistently questioned the opinion that salmon are unfailingly true to their native rivers. "We fail," he said, "to find any evidence of this in the case of the salmon of the Pacific coast, and we do not believe it to be true. * * * They may come into contact with the cold waters of their parent rivers, or perhaps of any other river, at a considerable distance from the shore * * * in a majority of cases these will be the waters in which the fishes in question originally were spawned." Dr. C. H. Gilbert, after a prolonged study of the Sockeye salmon, has fully adopted my view and has very definitely pronounced the opinion that salmon return for spawning, not only to the original river of their nativity, but to the very spot where they were reared as fingerlings. In such case their "homing tendency" is far more rigid in its workings than has been suspected. My own statement, published twenty years ago, and repeated in a second report in 1912, on the habits of Canadian salmon was that, "Each river has its own race of salmon," and in a paper before this Society in 1916,* I referred to a small stream, or rather creek, which produced a race of Sockeyes whose flesh was as dark-colored as beef, and which in this and other features, contrasted with the great schools passing through the same estuarine waters to the Skeena river, a few miles away. The Skeena salmon canners only netted this creek in an emergency, when the Sockeye supply of the main river was insufficient to fill the cans, the objection being that this small creek produced only salmon having meat of the dark repulsive color referred to.

* "The Red Color of Salmon's Flesh, etc." Trans. Amer. Fisheries Soc., XLVI, 1, Dec., 1916, p. 55.

Salmonoids are Recent and Plastic.

Authorities are agreed that the Salmon and its congeners have been evolved in the latest geological times, none of them occurring as fossils, like the Ganoids, excepting in comparatively recent strata. Their plasticity and variable character are no doubt due, as Dr. Gunther held, largely to their recent origin, which contrasts with that of older and more stable fish types. Representatives of the group have been found in the Miocene and Pliocene deposits, and specimens of *Osmerus* and of *Mallotus*, enclosed in rounded nodules, are abundant in some Canadian Pleistocene clays and not distinguishable from existing species. The occurrence of land-locked smelt in lakes in the Maritime provinces, and as far inland as the Gatineau lakes, Province of Quebec, 600 or 700 miles from the sea; and especially the land-locked Salmon of Quebec, New Brunswick, and Maine lakes, all point to a marine origin of Salmonoids partially or wholly acclimatized to fresh-water conditions. The Chamcook lakes of southern New Brunswick abound with land-locked salmon, and these lakes have been elevated 90 feet by subterranean power, though the distance separating them from the sea-shore is not more than a mile or two.

Land Elevation Has Defined Salmon Rivers.

When a submerged area becomes dry land and the ocean recedes, the folds and channels of the sea-bottom become valleys and river channels. The heat of summer and the frigid conditions of winter affect these exposed depressions; and rains, ice, frost, and all the forces of atmospheric denudation, enlarge and deepen them. They become worn into more or less sinuous river-channels draining the surface of the land. Hard strata resist more than soft strata, and water-falls and rapids are formed, but continuity with the ocean is never cut off. What do these changes involve, so far as the movements of fish are concerned? Those sea-fish which deposited their spawn in shallow inshore areas, or in brackish inlets, would find their breeding resorts lifted up, removed as it were far from the sea, and accessible only by a more or less lengthy and sinuous channel. That the channels in the sea are often continuous with the channels of river valleys on land has been clearly established. The best examples, perhaps, are those described by Professor George Davidson, (Proc. Calif. Acad. Sci. 1898,

vide Science, April 22, 1890). Along much of the Pacific coast the sea-bottom descends to 2000, 2500, or 2700 fathoms, within 50 miles from shore. A platform, say 10 miles wide, slopes to 100 fathoms depth, and the edge of this submarine shelf is scalloped by a series of underwater fjords or inlets, at least 30 in number, along the Californian coast alone. Many of these sloping valleys are in direct line with the rivers on land, some being really a continuation of the other, as at Monterey and Carmel; but others do not penetrate the dry land as, e. g., opposite King Peak and San Pallo. Some geologists regard these chasms or channels continuing from the sea on to the land-superficies, as dislocations and faults, and produced by drainage denudation; but this cannot be for the general evenness of the littoral plateau on either side of these submarine gorges is most marked. It is necessary to study the form and the drainage features of the adjacent land in order to decide the undoubted origin of these valleys. If the Salmon were originally a sea fish, pure and simple, and had the established habit of moving inshore to spawn in the shallows at the head of the under-sea valleys and channels, into most of which freshwater streams would pour, rendering the upper parts brackish, and during the rains and snows of winter, almost fresh, that habit would continue after the raising of the coastal shelf had begun. Migratory birds still adhere to their old established routes in spite of changes in the surface of the earth, indeed, the late Professor Alfred Newton, of Cambridge, England, often recalled the faithful persistence of woodcock in nesting near a town in the County of Norfolk. The wooded copse where he saw the nest when a boy, was partly cut down, houses were built, new streets laid out, but years after in the same spot he found, after these changes, the woodcock continued to nest and rear their young. Their annual migration to and from England continued not only to the same county and the same town; but to the identical corner of a small bushy copse, notwithstanding that all the surroundings and familiar features had altered. Is there not every ground for holding the opinion that salmon are as true as birds to their breeding resorts?*

* In opposition to the view, which I here advocate, the case has been triumphantly offered of salmon resorting to streams where no salmon could previously have spawned. Apart from the difficulty of proving that no salmon ever frequented such streams, I would point out that living organisms generally to avoid overcrowding migrate to new areas. The surplus must do so or the young will perish.

Migration Tendency Ineradicable.

Habit is amazingly tenacious and persistent. It is so strong that it seems to pass to successive generations and reappears with undiminished strength as an ancestral tendency. It is true that the English skylark, which soars to considerable heights when it sings, has lost that habit in New Zealand, and the strange spectacle is offered of the imported, acclimated skylarks singing their wonderful song, while indolently seated on a stone wall or on a wooden fence. On the other hand, the Apteryx or Kiwi, that ancient type of wingless bird which survives only in New Zealand, still tries to hide its head under the paltry stump, the small remaining vestige of its wing, when it goes to sleep; the most curious and pathetic case of persistence of habit known to scientists.* Our dogs before slumbering usually move round and round on the carpet, or even the stone floor, illustrating the survival of their ancestors' habit of smoothing down the coarse stubble or grass in the form or a lair or nest. With regard to Salmon—Inspector W. L. Calderwood, the well-known Scottish authority, in his report (Scott. Fish. Board Report, 1910, p. 7), says, having regard to their surpassing economic importance, it is "fortunate that the Pacific coast species have acquired the habit of entering fresh-water at all;" but this does not accurately represent the case, for these fish merely have adhered to their ancestral habit of seeking the old established spawning grounds. They have never wavered, if the view here set forth be the true one, in making their way to the old resorts, century after century. Topographical and physical changes have left the habit unchanged. Even so strong an advocate of the fresh-water origin of the Salmon as Sir Herbert Maxwell admits that environment has little influence on the migratory fish, and he speaks of "heredity" as determining the lateness or early character of salmon rivers, declaring that "the earliness or lateness of a salmon river depends not so much on the nature of the water, or its channels, as on the hereditary peculiarities of the race of fish frequenting it." (Salmon and Sea Trout, 1898, p. 226). He refers, in this connection, to the strong impulse

* The late Professor H. N. Moseley (Oxford) of this example remarked: "How strong is the tendency in birds to preserve their habits. I know of no more striking instance than this. (*Notes of a Naturalist on H. M. S. "Challenger."*)

which compels birds to return to their ancestral home. If my view be correct, it is the stronger impulse or habit which has prevailed, viz., that relating to propagation, not the weaker one, the mere desire for more abundant food, on which weaker stimulus reliance is largely placed by the advocates of the fresh-water origin of the salmon. Food is by no means wanting in most salmon rivers, indeed, vast schools of trout, and the parr, smolts, and even grilse, of the salmon, experience no lack of food while living in fresh-water, neither does the ouananiche or land-locked salmon.* The greater and lesser whitefishes (Coregoni and Argyrosomi), the lake- and brook-chars (Salvelini) and the graylings (Thymalli)—all Salmonoids, are under no necessity for seeking the ocean in order to avoid starvation, though it is true that food might prove insufficient for the innumerable hosts of Pacific salmon in the western rivers of this continent. Had the sea-migrating habit not been adopted by the various Oncorhynchi, natural laws would have reduced their numbers, no doubt, and the fittest though far fewer in number would have survived. It must be noted, however, that, in some of the interior western lakes, land-locked dwarfed species of Oncorhynchus occur, so that they must find sufficient suitable food.

Salmon Resemble Other Sea Fish.

If my interpretation be correct, the salmon is not unique, nor is it abnormal, in its migratory tendencies. Indeed, it has, like other fish, never changed its habit, but repairs to the ancestral breeding localities, regardless of the geological and topographical changes wrought in the course of long centuries. It is true, the surroundings of the shallow, gravelly spawning beds have changed; their former salinity has been exchanged for fresh-water conditions, the spacious bay or creek, washed by the daily tides, or the shallow marine fjord, has become an inland lake, or a river gorge deepened by ice and snow-water floods; but as the connecting channels

* Sir Herbert Maxwell himself refers to an example of the migratory impulse in very young salmon, which seems to be fatal to the theory of "freshwater origin." In an early salmon experiment it was found that smolts of the sea salmon prevented from descending to the sea for a year, became so impatient to get to salt-water that "Some of them leaped out of the water and perished on the banks," though food was given them plentifully and they were in their supposed natural habitat.—(*Salmon and Sea-trout, 1898, p. 222*).

become slowly elevated with the rising of the land and afforded drainage for rains and melted snows from the mountains and raised upper areas, the salmon's habit of seeking the accustomed spawning locality still persisted unaltered. The salmon must needs find its way up the tortuous and often difficult channels that afford the only access to lakes and streams where it was hatched and reared.

Such typical sea-fish as the Gadidæ seem to lend support to my hypothesis. Some, such as the Tom-cod (*Gadus tomcod*) habitually prefer brackish water; but others, like the Lake Cusk or Ling (*Lota vulgaris*) have assumed the strictly fresh-water habit.* The smelt, flounder, candle-fish or eulachon, capelin, and other sea-fishes often migrate into fresh water, and some become wholly non-marine; even the hake (*Phycis chuss*) is found at times far up rivers, where the salinity is low, and where (as in the Kennebecasis, New Brunswick) they can be taken with baited hooks through the ice in winter. A variety of sea-herring is found in the Baltic, and in fresh-water lakes adjacent, and many Clupeoids occur in rivers and lakes of this continent which never reach salt-water, though the shad and alewives spend most of their life in the sea and resort to rivers only to spawn.

All changes in nature are gradual, and if a fish, either young or adult, is found to die, when transferred from salt-water to fresh-water suddenly, no argument regarding its ancestral habitat can be based on so unnatural a procedure. There are many Salmonoids like the three or four species of Bathylagus, and the Microstomidæ (Nansenia) and the Argentines, which are strictly marine, indeed are deep-sea types; just as the whitefishes (*Coregoni*) and the Graylings (*Thymalli*) are strictly fresh-water, although some species of the former venture into the salty estuaries of Hudson's Bay and James Bay.

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* The European species is reported to occur in the waters of the Upper Baltic, but as Professor Alexander Meek observes, "has not been observed to spawn in the Baltic; and therefore appears to make an anadromous migration."—(*The Migrations of Fish, London, 1916, p. 236*).

Synopsis.

1. The Salmon is a sea fish, and feeds in the sea, and maintains health and vigor in the sea, but loses condition, becomes emaciated and often diseased in fresh water. Land-locked varieties are abnormal and illustrate acclimatization, like the fresh water shark of the River Amazon, or the lake ling or cusk, which must have been marine at one time.
2. The eggs and young of the salmon have through a long period of acclimatization become accustomed to their new environment, but the present gravel shallows at the head waters were once sandy or gravel areas in marine bays or estuaries. Geology teaches how such areas, the salmon's ancestral breeding areas, have become by elevation, first brackish, and finally pure fresh water areas. Smelt, shad, alewives, striped bass and other species are marine, but come into brackish or fresh water, at certain seasons of the year.
3. The elevated spawning areas of the salmon have never ceased to have connection with the sea, and salmon rivers are the persisting drainage channels, and have enabled the schools of salmon to continue resorting to their ancestral breeding areas though often involving very lengthy and perilous migrations.

CONCERNING THE PROTECTION OF FISH, FISH FOOD AND INLAND WATERS.*

By Dr. James Alexander Henshall,
Cincinnati, Ohio.

It may be well to say, in the first place, that, of equal importance with the proper protection of fish, and the replenishment of waters, is the proper protection of the waters themselves and the fish food they contain. Indeed, there are those who deem the latter measure of more real and permanent benefit than artificial stocking. They urge that if the waters are kept free of pollution, and practicable fishways established at dams and other obstructions, the natural increases of fishes would render stocking by artificial means unnecessary. This view seems plausible enough were the primitive conditions of the waters preserved and maintained. But such is not the case, and never will be.

The natural conditions of all waters in the thickly settled portions of our country have been changed. This change has been brought about by various activities and utilities that are the result of the progress of civilization. Among them are the industries of lumbering, mining, manufacturing and agriculture, and the sewage of towns and cities.

With lumbering it begins with logging. The breeding places of the trouts and grayling are in the tiny streams forming the headwaters of creeks and rivers. In their primitive state they were in the midst of coniferous forests, in whose solitude and shade and banks and borders of these rills and rivulets were clothed with a dense tangle of verdure, consisting of mosses, ferns and semi-aquatic vegetation. The spongy soil was saturated with moisture that not only maintained and replenished the small streams, but was essential to the reproduction of the larvæ of myriads of insects, and the minute crustaceans and mollusks that form the first food of the baby fishes.

* A part of this paper was read at a meeting of the American Fisheries Society a number of years ago, but as the writer was not present, the article was not discussed, and no action was taken by the Society. It is now presented in an amplified form, in the hope that some action may be taken, by resolution or otherwise, whereby the attention of the Federal and State Governments may be invited to a consideration of the matter, and to the necessity for the enactment of such laws that will prevent the lamentable destruction of fish and fish food that now obtains in many states.

Then these secluded precincts were invaded by the lumberjack with his axe. The forest soon disappeared, the gloom and deep shadows of the arboreal recesses were dispelled by the admission of the scorching rays of the summer sun and the hot, dry winds of the highlands; the moisture was dissipated, the vegetation shriveled, while the streamlets dwindled and finally disappeared entirely during the summer months. With these changed conditions went the food of the young fry. The breeding fish, failing to reach their former spawning grounds, in consequence of the diminution of the streams, were compelled to utilize the gravel beds at the lower reaches, where the food of the young fry existed in but limited quantity.

Then with the melting of the snows came the spring rise, and with it the logs of the lumberman, plowing out the beds on the gravel bars, scattering the trout fry and killing many of them. In Michigan, in each recurring spring, the logs plowed up the spawning beds of the grayling, destroying the ova and fry almost entirely, season after season. To this cause alone, is to be charged the almost total extinction of the grayling in Michigan waters, and not to overfishing; neither have they been driven out entirely by the incursion of trout, as has been alleged. Before the era of logging brook trout and grayling had existed in amity for all time, in at least two or three of the grayling streams, where I caught trout and grayling in about equal number as late as 1868 to 1873.

The mining of minerals and the smelting of ores can not be operated without water, consequently, the streams in the neighborhood of mines become discolored and impregnated with deleterious matter that destroys utterly, the food of fish fry, covers up the spawning beds with silt and debris, and eventually pollutes the stream to such an extent that but few, if any, mature fish can survive in them.

The offal from distilleries, if any remain, and the sawdust from sawmills, likewise settle on the spawning beds, so that if any fish eggs are deposited they are smothered and the embryo perishes. Chaff from grist mills and sawdust from the lumber mills become lodged in the gills of mature fish, causing inflammation and death. Coal mining is also fatal to life, inasmuch as the washing of coal, as now practiced, not only discolors the water,

but the coal dust is deposited on the spawning beds, and if breathed in by the fish, old or young, clogs the gills, and, from the well-known hardness of carbon, irritates and inflames them.

The waste matter from oil refineries, paper mills, starch factories and other industrial plants where poisonous and noxious chemicals and substances are used, or occur as by-products, is very destructive to fish of all ages, and is a more potent factor in the destruction of fish food than any agency mentioned.

As a case in point I might mention that I was once making a collection of Ohio fishes for the museum of the Cincinnati Society of Natural History, and was seining a creek not far from the city. There were two branches to the creek, one coming from the west and running by a large starch factory, the other coming from the east. The bottom of the west fork was covered for a mile, from the factory to the main creek, with the offal from the factory, and the water was more or less discolored. The water of the east fork was perfectly clear, with a gravelly bottom, and contained the usual variety of small fishes as sunfish, suckers, minnows and darters; but no fish, large or small, was taken from the west fork, nor was there any evidence of fish life, to say nothing of fish food, nor could any survive in the polluted water.

The argument is often advanced that the various industries just alluded to must, as a matter of course, be tolerated and maintained, even at the cost of the loss of all fish life in inland waters. But this is not necessarily the case. Their evil effects can be prevented, in a great measure, by compelling such plants to run the offal and waste water into settling ponds or septic tanks before allowing it to flow into the stream, as is now being done in some places.

By the vigilance of fish wardens the minor evils of illegal fishing, illegal sale of fish and dynamiting can be, to a great extent, prevented, as punishment for these offences is provided for by statutory enactment.

All of you are doubtless more or less familiar with the loss of fish life from the causes enumerated, but there is another agency of fish destruction, not generally suspected, that is the cause of untold havoc and slaughter, and is so appalling and widespread in the western states, that in comparison with it all the other factors mentioned sink into insignificance. It is the wholesale

destruction of fish, both large and small, by means of irrigation ditches.

No one, except the rancher and those who have investigated the subject, can have a realization of the awful loss of fish life, of the wanton sacrifice of millions of God's creatures, left to gasp out their little lives on the meadows and grain fields in some of the western states. Often the stench arising from the decaying fish is intolerable; it smells to heaven. And yet no effective steps have been taken to prevent it by the national or state authorities. This is all the more lamentable as it could so easily be obviated and prevented.

It is very discouraging to fish culturists in the western states, after hatching and rearing fry and fingerlings with much care and labor and solicitude, to have them stranded and destroyed on the fields of the selfish or thoughtless rancher. It seems to be impossible, by argument or reasoning, to impress the average legislatures of the western states of the importance of screening irrigation ditches at the intake. There is also needless and unwarranted opposition to the screening of ditches, not so much on the part of a majority of the farmers and ranchers, as by the average member of the state legislatures, who pretends that it would entail too much trouble and hardship for the rancher to keep the screens clear of leaves and trash.

By his opposition to screens he hopes to catch the farmer's vote. But the farmer knows that the streams are comparatively clear of leaves and trash in the summer, and that but little attention would be required to keep the screens free and open, during the season of irrigation. I know, personally, of ranchers who, of their own accord, placed screens at the head of their ditches, and who assured me that but little attention was needed to keep them clear during the summer months. I do not believe that the majority of farmers are more selfish or thoughtless than other men, or have less regard for life, even that of a helpless fish; and if screen laws were enacted I believe they would be cheerfully obeyed by the ranchers.

In order to meet and overcome the objection to screens, I devised a very simple affair, that would be just as effective in keeping fry and fish out of the ditches as a screen, or more so, and moreover it would need no attention after being put in place, and

would not retard or interfere with the flow of water. It is a simple paddle wheel, of a size commensurate with the capacity of the ditch. For the smallest ditches a square shaft with four paddles nailed directly to it, and with a spike at each end for bearings, would be sufficient. The cost would be a trifle, and it could be made in half an hour. For ditches with more depth of water a wheel with eight paddles, affixed to an octagon shaft by arms would be better. For irrigation canals a larger and more expensive wheel would be required, but the principle is the same in all.

The wheel, whatever its size, is installed in a short flume, at the head or intake of the ditch, with a fall sufficient to insure a current to operate the wheel. No fish, large or small, will pass it when in motion, and any foreign substance would pass under the wheel by raising up the bearing in the V-shaped slot, when it would immediately resume its position.

When I was superintendent of the fish hatchery at Bozeman, Montana, I made three efforts to have the device made compulsory by incorporating such a provision as a section of the game and fish laws of Montana. But twice the committee on fish and game cut it out for the reason that it might jeopardize the rest of the pending bill. The third time the committee unanimously recommended its passage, and it seemed to be in a fair way of adoption, but at the last moment, through the influence of the commercial and irrigation canal corporations, it was defeated. I might add that this fish wheel, if placed at the spillway of a pond or dam, will prevent the fish from escaping.

In view of the extensive schemes of irrigation contemplated in the arid regions of the western states by the Federal Government, and also by a few of the states, the proper protection of fishes should be provided for in advance; after awhile it will be too late. A few years ago a big irrigation canal, constructed by the government, having its source in the Truckee river, in Nevada, was opened. Government and state officials were present to celebrate the event. An account of the affair in a local newspaper at the time said:

"The gates of the dam were lowered and those of the canal were raised, the great flood pouring into the huge ditch. The reclamation project in Nevada was then formally dedicated. When the gates of the river dam were lowered, the bed of the

stream below was dry. In an instant the party found diverting sport in catching the large trout that were floundering on the rocks."

I leave this account for the consideration of every angler and fish culturist, and perchance to our federal and state representatives. It has been said that the immense storage reservoirs to be constructed in connection with the reclamation projects will furnish a home and a haven for millions of fish—but not on your life. These reservoirs will be built in narrow mountain gorges, where the water will be too deep for fish life to exist, and the rocky bottom and sides will forever preclude the existence of fish food. The Roosevelt Dam in Arizona, already constructed, is more than three hundred feet high.

It is popularly supposed that fish should abound, thrive and multiply wherever there is a reasonable volume of water, even if polluted or contaminated by deleterious matter that is destructive to fish food, if not to the fishes themselves. Sometimes in planting young fish the serious mistake is made of dumping fry or fingerlings in the main body of streams, or in the open water of ponds and lakes, where but a small amount of fish food exists, and where they are likely to be swallowed by larger fish.

It has been said that the proper way to train a child is to begin with its grandmother; so the proper way to protect the fish of inland waters is to begin with the water itself. Practicable fishways should be placed at every dam or other obstruction. Manufacturing plants and mines should be compelled by law to provide settling ponds for waste liquid products and septic tanks for poisonous offal, so that the overflow would consist of comparatively innocuous water.

In all states where irrigation is practiced, laws should be enacted for some effectual device for keeping fish out of irrigation ditches. Close seasons for all game- and food-fishes during the breeding periods should be established, and severe penalties should be imposed for the violation of such laws. Every peace-officer and court official should be made fish and game wardens by virtue of their offices, with full powers, in addition to the regularly appointed wardens.

The sewage of towns and cities is another problem that will have to be dealt with eventually, though at present it receives but

little attention. If these things can be accomplished better in the future than they have been in the past, and more care taken in stocking waters with fry and fingerlings by planting them in the smallest tributaries, in shallow and protected places, with abundant aquatic vegetation where there is a reasonable amount of food suitable for them, we shall be on the road to a better state of things. By the continual stocking of waters, intelligently, with fish artificially propagated, a fair amount of fish life may still be maintained in inland waters, even in the older states.

It is manifestly the province and apparently the duty of this Society to employ every means to educate the people to a proper sense and appreciation of protective measures, not only for fish, but for the waters as well, and to use its influence in shaping such wise, adequate and effectual legislation as may be necessary to that end.

As the United States Department of Agriculture has begun the good work of protecting and conserving our game-birds and mammals, the question naturally arises, why should not federal protection be extended to fishes in public waters? I can imagine no good reason why the United States Bureau of Fisheries should not take an active interest in preventing the pollution of public waters, and in protecting the fishes that inhabit them. In anticipation of the extensive irrigation projects contemplated by the General Government in the western states, the influence and timely action of the Bureau would prevent the almost total depletion of the streams of fish life that would otherwise surely follow.

The streams of the Rocky Mountain states are as yet comparatively pure and undefiled, to a great extent, and should be as productive of fish life as when first viewed by Lewis and Clarke. But unless the awful slaughter of the innocents by irrigation ditches is stopped, and stopped now, the beautiful mountain streams of the golden west will eventually become barren wastes, void of fish life, for which, not the rancher, but the representatives of the people, the Congress and the State Legislatures will be to blame.

PLANTS OF IMPORTANCE IN POND FISH CULTURE.

By Dr. Emmeline Moore.
State Conservation Commission,
Albany, N. Y.

In the brief time at my disposal, I shall stress the need of conserving certain pond plants which contribute to the food supply of the young fish.

The Bureau of Fisheries has given me the opportunity to make some investigations along this line, and the directors and superintendents of fish cultural stations have facilitated my work in every way with results which indicate a more efficient treatment of the natural forage supply in the ponds.

The problem thus far has centered around observations of the food taken by the advanced fry and fingerlings of bass, sunfish, buffalo-fish and other pond fish. My point of attack has been to make a botanical survey, as it were, of the contents of the fish stomachs, a survey which had for its object the determination, not only of the table of contents, but of the actual plant materials which supply food for the organisms on which the fish feed; that is, by working back to the plant substance which is drawn upon either directly or indirectly by the organisms upon which fish feed. In the last analysis it is always plant substance.

A natural food is required by the young pond fish. As you know, they will not accept artificial food. For this reason, then, the necessary first step has been to reduce the actual food taken to its lowest botanical terms, so to speak, and thus to study the forage substance which the ponds contribute in building up the large supply of natural food for the young fish.*

The tables were compiled from examinations of the food content of fish which were taken at weekly intervals during the early growth period, that is, of the advanced fry and fingerling stages. The tables show a preponderance of chironomid or midge larvæ,

* At this point Dr. Moore displayed tables which showed the food content of young pond fish examined at the U. S. Biological Station, Fairport, Iowa. Since the Louisville Meeting these tables have been published, appearing as a part of the report of the U. S. Commissioner of Fisheries for 1919. See Appendix IV, Bur. of Fisheries Doc. No. 881.

and cladocerans in the fairly wide range of organisms taken. The prevalence of these forms in the dietary has led to a consideration of the food of these organisms. The following table shows the nature of the food of certain midge larvæ which were conspicuous in the food of the young bass.

FOOD OF MIDGE LARVÆ.

Species of larvæ	No. examined	Source		Algae Taken as Food							
		Natural habitat	Fish stomachs	Mougeotia	Spirogyra	Zygnema	Oedogonium	Hydrodictyon	Desmids	Diatoms	Miscellaneous plant substance
		per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per ct.	per c(.
a*	100	†		90	1		5	3	1		
a*	100		†	85	8		3		4		
b*	50	†			3	2	70	6	4	5	5
b*	50		†		15		70			3	2
c*	50	†			2		85		8		5
c*	50		†		8		83		8		1

*a = Orthocladius nivoriundus. †= Source.
*b = Pseudochironomus sp.
*c = Chironomus nigricans.

My attention was directed to the study of the midge larva, *Orthocladius nivoriundus*, because on examination of the bass stomachs this larva formed a large percentage of the food supply during the latter part of June and early July. The larval cases were found to be very abundant in the floating algal mats of *Mougeotia*, a delicate filamentous green alga which forms a thin scum at the surface of the pond, particularly in the sheltered portions, or, when very abundant, effecting a delicate drapery over the erect plants with which it comes in contact.

Two other chironomids apparently sought after by the young fish belong to the genera *Pseudochironomus*, species undetermined,

and *Chironomus*, species *nigricans*. Their habitat was also in the upper strata of the ponds among the algæ, or scums.

For the purpose of tabulating the data on the kind of food taken by the chironomid larvæ which at the time made up a large percentage of the food of the young fish, a suitable number for examination were selected both from their natural habitat in the ponds and from the contents of the fish stomachs. They are such voracious and continual feeders that in fresh specimens their food content is easily ascertained. A larva is mounted in water on a glass slide and covered with a cover slip. Then, by exerting gentle pressure on the cover in the region of the rear of the body and pressing forward, the contents are forced out of the alimentary canal. Thereafter the problem resolves itself into one of identification of the algæ present.

By reference to the table it is seen that the algæ *Mougeotia* and *Oedogonium* are highly prized as food by the species of chironomids indicated. *Mougeotia* is a very delicate alga and the larvæ prefer it to all others when it is present, as was observed when rearing numerous larvæ in the laboratory in aquaria, where a mixed supply of algæ was provided. The larvæ reared in this way always sought their forage among the filaments of *Mougeotia* which they applied to their larval cases as a reserve. *Oedogonium* is the other favorite alga with these chironomids. Spirogyra, desmids and diatoms appear to be taken in lesser amounts by the species of larvæ under observation. Other species, doubtless, make use of them in larger measure and at different seasons. As our knowledge of the feeding habits of the chironomids becomes known the variety of algæ taken as food will be found without doubt to be very great. This table indicates the forage ground of but three species out of a probable host which subsist on the common algal mats of our ponds, and signifies the value of these plants in the ponds in terms of fish food.

There are some species of algæ which, so far as I am aware at present, do not enter directly to any great extent into the forage of the chironomid larvæ. They are the coarser forms, the *Cladophoras*, *Pithophora*, and the like, coarse in texture and difficult to appropriate for food, but valuable in the economy of the pond since they afford lodgment upon their filaments of the useful diatoms.

The algæ may be regarded as the *piêce de resistance* of the chironomid larvæ which are sought after by the young fish foraging in the upper strata of the pond waters. Unfortunately, through lack of appreciation of their worth in the economy of the pond and the tendency of the scums to be regarded as untidy and a nuisance, they have often been ruthlessly discarded from the pond waters. In one stroke, by the injudicious use of chemicals, the vegetation upon which these organisms subsist may be destroyed, and in that stroke the "meat supply" of the young fish.

By referring to the tables* again on the food content of the advanced fry and fingerlings, we find that the water fleas, or cladocerans, are conspicuous in the food of the young pond fish. The various investigators of the habits of the water fleas have contributed to our knowledge of the food habits of these small organisms, the most important contribution being that of Dr. E. A. Birge, in his "Plankton Studies of Lake Mendota," II, Trans. Wis. Acad. Sci., Vol. 11, 1896-7.

I have found that the water fleas often feed upon a single type of alga in the ponds, the algæ, of course, being extremely minute to be accommodated by these small organisms. At Fairport, Ia., one of the ponds developed a heavy culture of the Blue-green alga, *Aphanozomenon*, and simultaneously with it there arose an almost pure culture of *Daphnia pulex*, which fed upon the *Aphanozomenon* during a period of six weeks at least when it was under my observation. It was a remarkably interesting sight to observe the daphnia under a microscope winnowing into the food cavity a continual stream of this plant and to take it with such apparent relish! This myriad host of daphnia doubtless contributed to the large output of young Channel Cat which had been spawned in the pond, but whose dietary was not determined in the early stages of growth.

At other stations similar observations on the food habits of cladocerans were made. At Louisville, Ky., in one of the ponds, daphnids were feeding on a heavy culture of a minute alga known as *Botryococcus* and in another pond on the disorganizing substance of a heavy growth of *Ceratium*. At the Bullochville, Ga., station the daphnids were at one time utilizing the extremely

* Published Report. Loc. cit.

minute alga, *Dictyosphaerium*. While these observations show that the daphnids may derive their food supply for a more or less continued period on a single type of alga, provided it is abundant enough, it is found that an assortment of plant material in a fresh or partially decomposed state may be wafted into the food stream.

The mayfly and caddisfly larvæ which contribute to the food supply of young fish are largely herbivores, while the dragonfly and the damselfly larvæ, beetles, etc., are primarily carnivores, feeding on animals whose food in turn, however, is vegetable.

In this consideration of the dietary of young fish, I have emphasized particularly the algal resources of the ponds. I have omitted reference to the contributions of the larger aquatic plants, the potamogetons, the myriophyllums, water-weed, Chara, etc., not because there is no evidence to produce in their favor, but because propaganda in this direction seems less necessary. There exists already among fish culturists a wholesome respect for their presence in the ponds. The algæ have not fared so well and must be considered in providing an abundant supply of natural forage for the young fish.

EXPERIMENTS IN THE ARTIFICIAL REARING OF FRESH-WATER MUSSELS IN TROUGHS UNDER CONDITIONS OF CONTROL.

By F. H. Reuling,
United States Bureau of Fisheries,
Fairport, Iowa.

The rapid depletion of the fresh-water mussels of the streams of the United States is a subject too well known to be dwelt on here. Persons directly, or indirectly, concerned with this swift exhaustion of a natural resource which furnishes the raw material for the support of such a large and typically American industry as the manufacture of fresh-water pearl buttons, are quite familiar with the steps that the United States Bureau of Fisheries has taken for some years past to artificially propagate these mussels on a commensurably large scale.

This work, which involves the collection of fishes on a large scale, infecting them with glochidia of suitable species of mussels and liberating them again in suitable waters, is described in publications of the United States Bureau of Fisheries.* While this work is undoubtedly effective and beneficial results are apparent, the desirability of improving the work, so that definite and local plants can be made with young mussels that have passed at least one growing season of independent life, has been cogently realized; a method of rearing young mussels in quantities under conditions of control and making definite plants on particular and suitable bottom areas.

With these facts in mind and as a part of a general plan, the writer was assigned the problem of rearing mussels in troughs with running water, by Mr. A. F. Shira, Director of the United States Fisheries Biological Station, Fairport, Iowa. The experiments were commenced in July, 1917, and continued for three summers.

Prior to the time these trough experiments were inaugurated, but few young mussels had been artificially reared under conditions

* "The Fairport Fisheries Biological Station, etc.," by R. E. Coker, U. S. Bureau of Fisheries Document No. 829, 1916.

of control. In the summer of 1914, Dr. A. D. Howard,* of the Fairport Station, reared about 200 young mussels of the species *Lampsilis luteola* from an artificial plant in a floating crate in the Mississippi River. The same summer Mr. A. F. Shira, then at the Homer, Minnesota, Station, reared six young mussels of the same species in a small balanced aquarium. It may also be noted here that the same summer several hundred young mussels of the same species were first reared in one of the ponds of the Station.

The experiments were conducted in a series of eight galvanized iron troughs, placed at a sufficient low level to receive a gravity supply of water from Pond 1D. This pond was supplied by gravity from the reservoir which in turn received its supply direct from the Mississippi River through the pumping plant. The water in pond 1D remained comparatively clear throughout the season and this was one of the primary considerations in locating the troughs. The troughs were twelve feet long, one foot wide and eight inches deep, painted with asphaltum, and each had its independent inflow from a common, screened supply pipe in the pond. The bottom of each trough was covered with fine sand to a depth of about one-half inch.

Records were kept of the progress of the larval mussels through the process of development and when they had reached that stage when they were ready to drop from the fish, counts on the fish gave a close approximation of the number dropped in the trough.

The results of the experiments the first season were quite meager, as only seven young of *L. luteola,* varying from 6 mm. to 17.8 mm. in length, and four *L. ligamentina* with an average length of 2.6 mm. were reared. However, in case of the *ligamentina* the results were very encouraging, as it marked the first instance of juveniles of this species being artificially reared to this size.

During the season of 1918, greater results were obtained with *luteola;* the young mussels being successfully reared in four troughs. In one trough a count of 746 was obtained. The experiments with *ligamentina* gave negative results, though a lack of glochidia for infection greatly handicapped the work with this species.

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* "A New Record in Rearing Fresh-Water Pearl Mussels." A. D. Howard, Trans. Amer. Fisheries Society, Vol. XLIV, No. 1, 1914.

The results during the past season have been still more gratifying. Young *luteola* were obtained in each of five troughs planted with this species. In one trough 2008 were counted at the end of the season. These little mussels varied in length from 9 mm. to 17.5 mm. The growth comparing very favorably with that made by the young of this species in their natural habitat. In one trough devoted to the river mucket, *L. ligamentina*, a total of 565 were reared. These little mussels varied in length from 5 mm. to 8.5 mm. In one trough planted with the yellow sand-shell, a count of 2006 was obtained at the end of the season, the young mussels varying in length from 5.5 mm. to 12 mm. The result of this experiment is highly interesting, in that it is the first record of the artificial rearing of this very valuable species in any quantity.

The 746 young *luteola* reared during the summer of 1918 were carried over the winter in a shallow crate bottom five feet square and eight inches deep, submerged in one of the earth ponds. During the summer an inventory of the crate bottom gave a count of 285 young mussels, a survival percentage of about 38 per cent.

The method of artificial rearing of young mussels as detailed above, denotes a distinct departure from the methods previously used, and gives the operator quite complete control of conditions throughout. The results have been such as to justify the continuance of the method on a much larger scale another season and plans are under way for materially increasing the facilities and equipment. Certain phases of the work, however, need further study and amplification. Additional information on the possible enemies of the young mussels in the troughs is needed; a study of their food should be made; and further experiments should be made to determine the most favorable bottom material for the troughs, whether fine sand alone, or sand with a slight admixture of silt, etc. Present indications are that fine sand is the most desirable bottom material.

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A WORD ABOUT FLORIDA'S FISH AND HER FISHERIES.

By J. Asakiah Williams,
Shell Fish Commissioner of Florida.

Man, in his earlier stages of existence, found nature a free storehouse from which he could draw at will. As population increased, the demands upon this storehouse increased. Then there came a time when the demand exceeded the available supply and man began to assist in his own support by conserving what he had on hand and by improving on nature, making "two blades of grass grow where only one grew before." To encourage such assistance, personal property rights became a rule of society. As men increased in numbers and greater demands were made upon nature's storehouse, it was found necessary to conserve further, and the laying hen was not killed, the sow heavy with pig was spared. Thus again was nature further assisted. But man, fulfilling God's command to "replenish the earth," became in some localities so numerous that even with this assistance, nature's storehouse was failing in its supply. Especially was this true in the fish of the streams, the game of the woods, the useful trees of the forest. Then society exercised its sovereign power over its nature's storehouse and passed regulations concerning the taking of the same.

Education as to the necessity for conservation is, of course, a forerunner of all conservation measures, and the enforcement of such measures is dependent to a large extent upon such education. Sometimes even our trial judges and prosecuting attorneys, learned in the law, fail to sympathize with conservation measures. Where there are such judges and attorneys, it is difficult to get convictions for violations of the law. It is needless to say that these men are honest and learned, yet they are ignorant of the reasons for and need of such laws. Fortunately, there are but few such judges and attorneys.

Conservation laws are curtailments of a man's natural privileges for the good of the majority. The taking of fish and game when not forbidden by law is not evil *per se*, because society has not seen

fit to regulate the taking. But where society has undertaken to regulate it, then the taking contrary to such regulations is evil *per se;* the community has exercised its sovereign power over its own property. "Thou shalt not steal," and he who violates society's regulations for taking from nature's storehouse, to his own advantage, steals from the rest of the community.

Experience has shown that conservation laws are necessary and that to get the best enforcement of such laws it also is necessary to remove (as far as is possible) from localities affected and from local politics, the power of such enforcement. Such laws have failed of enforcement where left to sheriffs and county police officers. A state head has been found to get the best results. The best possible protection and benefit to the fishing industries comes from state supervision. By this means, local conditions do not bias enforcement of the laws, and enforcement throughout the state is uniform. At the same time, the head is sufficiently close to be in touch with all circumstances arising and to familiarize itself with the peculiar conditions of each stream, lake, bay, and river. For these reasons a state control is the best solution so far found. Federal aid and assistance should be had upon request and by way of suggestion, but not by right of authority, for the reason that a federal head would be too far removed, and it would be far more difficult to regulate and legislate for each locality so as to conserve, and at the same time draw, to the greatest extent consistent with conservation.

Through ignorance and procrastination, a calamity has been and is being wrought upon us by the wanton destruction of our fish, game and timber in the greater portion of our country. At last, and too late for the pigeon and buffalo, a few of the states have awakened and have adopted good conservation laws, well enforced, for fish, game and forest. Other states are rousing from their slumber and have some kind of conservation laws, more or less enforced, for game. Fewer still have laws for fish, and a very few for forests.

Our Florida laws governing fresh-water fish are not worthy of the name. Such as they are, they are under the county police officers for enforcement; and that means no enforcement except occasionally in some localities. A large number of the counties

have local fresh-water laws, passed without scientific or working knowledge, and the results are unsatisfactory.

Our salt-water fishing legislation covers a period of many years without any general repealing act. As a result, it is almost impossible to tell what laws govern in many instances, and we have laws galore, probably 150 pages, ordinary book size. At the last session of the Legislature a general bill covering all needful legislation, (some 30 pages), and repealing all other laws on the subject, was introduced, but for want of time for discussion when it came up for passage and because of ignorance of its need and of its provisions, and also because of politics, its passage was prevented. Such a law would have been greatly beneficial to Florida. We will get it next time.

There are indications of a coming conflict in Florida between those interested in sport fishing and those engaged in commercial fishing. The sport fishermen are backed in their demands for waters in which commercial fishing shall be prohibited, by our coast cities and towns, which receive many tourists during the winter season; while the commercial fishermen are backed by the fish dealers of the state. There are fish in abundance for both and the solution to this problem must soon be had, for it would be a great detriment to commercial fishing industries if large sections of the state were unnecessarily closed to net fishermen.

For the purpose of this discussion, Florida's fishing will be divided into—

(1) Fresh-water fish.

(2) Salt-water fish, under which heading we include all fish except those that live in the fresh waters only. For convenience, the salt water fish will be divided further into—

(a) Shore fish, or those fish usually taken in bays and inshore waters; and

(b) Deep-sea fish.

From a commercial standpoint, Florida's fresh waters furnish large quantities of cat, perch, bream, and big-mouth bass. Each kind furnishes a supply in about the order named. As large as this commercial fishing is, it is but about half of what it should be. The rainfall of our state is great, hence we have numerous rivers, lakes and streams. The climate is subtropical, hence fish food abounds. By reason of mistaken ideas, there are many local

conservation laws prohibiting from being fished, except with hook and line, many lakes which should yield large quantities of fish for commercial purposes without injury to sport.

Now I wish to be clearly understood. Where sport fishing and commercial fishing conflict to the extent that the angler is deprived of his sport, and there is a demand for such sport, I stand for sport fishing in preference to commercial fishing. Sport fishing tends to clean living and good health. It is a sport enjoyed by old and young, male and female; and these are things much to be desired by the state for its citizens and to be much more highly prized than gold and silver. Yet in our state there are many lakes and rivers closed to all but hook and line fishing, upon which but little sport fishing is done. Again, the supply of fish in other waters is far greater than necessary for the angler, and in such cases the larger fish eat the smaller ones and, growing wise with age, refuse to take the hook and there is poor sport in fishing such waters. In many waters now closed, much valuable fish might be taken by trap and other such devices, so constructed as to permit the escape (or the return alive and uninjured, to the water) of all small fish, the waters being so fished as not to destroy or injure the fishes food or their breeding grounds.

In Lake Okechobee much destruction of food fish is wrought by commercial fishermen. This lake is about 55 miles in diameter and yields enormous quantities of food fish. It is said to have yielded $3,000,000 annually in catfish alone for several years. Seines a thousand yards long or more are used. The catch is held until the cats are skinned and weighed. The dealers prefer the cats and, to encourage cats only to be taken, foolishly limit the quantity of perch, croppie, bream and bass to be taken to, say, 20 pounds of scale fish to 100 pounds of cats. After weighing up the cats, the quantity of scale fish permissible is saved from the catch and the remainder is thrown dead overboard or, more often, cut up and used to bait another section of the lake to be seined hours later. This doubtless shocks you, as it does me. This practice is not generally known throughout the state. It must cease, for it is a crime against civilization, but we now have no law to prevent such acts, owing to our pernicious local laws.

Our salt-water shore fishes consist of shell and scale fish. We have in shell fish the scallop clam, which is not commercialized,

yet I am of the opinion that in some of our waters they are of sufficient quantities to be profitably taken. In commercial importance, the oyster ranks first among our shell fish. In many of our brackish waters they are found in paying quantities. Appalachicola has probably the largest natural oyster beds south of the Chesapeake. There oysters grow rapidly and to a great size. They are fat throughout the year, being eaten at all times by the citizens of the country.

Probably one of the largest known clam beds of the world is on the southwest coast of Florida. It is some five miles wide and fifteen miles long. Two large, modern, sanitary canning factories operate there throughout the year.

Of our scale fish, the mullet is by far the most important from a commercial and economic viewpoint. Commercially, it constitutes almost one half of all our scale fish industries; and economically it is the cheapest as well as one of our best fish. There are two distinct varieties:

(1) The common mullet, which is always with us; and

(2) The silver mullet, which visits our shores in the spring to spawn.

The common mullet (*Mugil cephalus*) spawns in the fall. There are reasons for believing that this mullet should be further divided into two separate classes, one of which lives in the fresh waters, only going to the salt waters for spawning. This type appears to be darker along the back and to have a blunter snout. To those of you who are scientific, I suggest that here is a field for investigation.

Before passing from mullet, I wish to say that we have a closed season on them from November 20th to January 20th for the east and south-west coasts of Florida, the time during which they mainly spawn. Recently on a trip along the east coast, I was informed that there are enough mullet now, about two years old, (too small to be taken this year, but which will be large enough for next season) to supply our catch for the next five years.

As important to us (and also to North Carolina) as the mullet are, there has been, so far as I know, but little investigation of their habits, haunts, food, and manner of reproduction, either by individuals, by the state, or by the federal government, notwithstanding they are a shore fish.

We made some investigations concerning their reproduction during the fall of 1918. The Florida Shell Fish Commission caused one of its deputies, C. H. Nesley (who claimed to have had some thirty years experience in artificial hatching) to make experiments. From other sources and from his reports, we know the following to be true:

(1) Mullet when ripe, by handling give forth freely both eggs and milt.

(2) The eggs are not adhesive, but separate freely.

(3) The eggs are heavier than salt water.

(4) Their eggs have been artificially taken and fertilized and within ten minutes thereafter have been found to be greatly increased in size.

I beg to refer you for details to the Third Biennial Report of the Shell Fish commission, pages 29, 30, 31 and 32.

Owing to the fact that some fishermen of that section (who are densely ignorant) made statements, at the request of a designing politician, to the effect that this Charles Nesley never hatched any mullet, some question has arisen whether he really obtained the results which he has claimed. Yet some of these same fishermen have informed me, by mouth and by letter, that the eggs so taken and fertilized grew in ten minutes to be ten times as large as when they were stripped from the fish, and that they personally had not seen anything further of the operations.

Nesley knew how to hatch fish. After this experiment, I had him hatch shad on the St. John's River. We purchased the jars and he erected the outfit. I saw the eggs hatching, and have some of the fish preserved. Before he made the investigation, Nesley was of the opinion that mullets spawned in fresh waters only. A change in his convictions is, in my opinion, an inward evidence that his report is worthy of acceptance. In the next place the small per cent of ripe mullet found with the catch of roe mullet was exceedingly small in comparison with our expectations; and, again, this in my opinion is an inward evidence of truthfulness and reliability. Again, he had no motive for deception. He is careful of his reputation as a fish culturist and he knew that his reputation was at stake. For the reasons given I would be pleased, when I have finished, to have a discussion on these questions:

(1) Where fish eggs can be stripped easily, are non-adhesive, are heavier than water, and when fertilized readily "set up," becoming many times larger than when stripped, is it probable that such eggs can be hatched by artificial methods?

(2) Could they probably be hatched by the method which Nesley claims to have proved?

Before passing, I must say a few words concerning investigations made by me regarding turtle. In Florida we have four varieties of sea turtle. In commercial importance, the green turtle (which is vegetarian) ranks first. Next in commercial value is the bastard turtle, which appears, in flavor, habits and form, to be a cross between the green and loggerhead turtles, although in my opinion it is a distinct species. However, I have no knowledge as to this. Then we have loggerhead turtles, which are flesh eaters. Their flesh is coarse and strong and is eaten by the natives, but has only a local commercial value. We also have tortoise-shell turtle, but they are rare.

Heretofore it has been held that the green turtle laid only in the West Indies. But from investigations I have made, I find they deposit their eggs also on the coast of Florida.

A turtle lays from 60 to 110 eggs at a laying. They commence laying in April or May and continue to lay until August or September. Upon the opening a turtle ready to deposit its eggs I found eggs shelled ready for laying; other eggs about grown, but unshelled; and still others in the earlier stages.

Turtles lay on moonlight nights and also on dark nights. It is my opinion that they lay once every two weeks during the season. Once ready to deposit her eggs, the mother turtle cautiously approaches the beach and, protruding her head above water, looks and listens. If any unusual sight is seen, or unusual sound is heard, she draws back her head and goes back to sea to approach the beach at some other point. After being satisfied that there is no danger, she crawls upon the beach at some point above high tide and first usually stirs up the ground in several different places. Then with her hind flippers she digs a hole about eighteen inches deep—remarkably deep considering the length of her flippers. In this hole she deposits her eggs, all in a pile. Then she covers them up and again, for five feet all around, turns up the sand so as to conceal from man or beast the exact location of the nest. Having

thus camouflaged the nest before and after depositing the eggs, she makes for the sea. It is while laying that turtles are generally taken. The hunter, finding them out on the beach, turns them on their backs and they become powerless.

The nest is deep enough not to be overheated by the sun's rays or chilled by the waters of the sea. An examination by day or night will show a warm, even temperature, the nest being just a little less heated than is a hen's nest. How the turtle in the first place ever found out that, in a hole eighteen inches deep and just above high tide, the heat of the sun and the cool of the sea would mingle and keep a steady temperature that would hatch her eggs and save her the trouble of sitting on the nest, is to me a mystery.

The fame of Florida's citrus fruits are known the world over. Fancy concerning them fills the minds of those who have not seen them and Florida is justly famous for them. But Florida's fishing industries are even greater; and when the superior quality of her fish become better known and her fishing operations are wisely conducted, improved and extended, they will increase many times in value. Recently one packer showed me his books and from his records we found that the fish he handled had brought gross to his firm a sum that, when added to what the carriers received for carrying the fish, amounted to about one and one half million dollars for one year. We have in Florida about 100 fish packing firms, of which some twenty each handle as much fish as this particular firm. One dealer once told me that he had on a certain day paid two men $800. for their week's hook-and-line catch of fish.

If you will pardon the digression, I will tell what befell me and what I learned within the last week, which illustrates the hospitality of a native Florida fisherman and his success.

A deputy was accompanying me on an inspection tour of his district. We were traveling by auto. He was mistaken as to the quantity of gasoline we had and about eleven o'clock at night, when seven miles from any hotel or similar institution, the gas gave out. My deputy said he knew a fisherman who lived near, a Mr. Carver, who was doubtless out fishing. "This man," he said, "has an outhouse with two single cots in it. We will go there and take charge." Following his suggestion, I found things

as he had described them. The outer door was unfastened. In we went and to bed. Before day in came the fisherman and, to his astonishment and evident delight, he found us in his beds, one on each cot. I offered to relinquish to him the cot I was occupying, but he would none of it, though he had fished all night and was weary. He reclined on the floor and told anecdotes for half an hour or more for our entertainment and kept us roaring with laughter. Many of the stories he told were on himself and equaled anything ever written by the immortal Mark Twain.

After thus entertaining us, he informed us that his wife was away on a visit and that he was an excellent cook and clean, neat housekeeper and that he would prepare breakfast; for us to go to sleep and he would have breakfast at sunrise, then wake us up, We protested until we saw that further protest would grieve him. We had a good breakfast; fat fresh mullet, perfectly cooked grits. (something we eat as bread and of which you know nothing, but the sooner you find out the happier your stomachs will be and the less indigestion you will have), and delicious coffee.

Our host was a typical Florida cracker fisherman, unlearned, talkative, honest, industrious, hospitable, confiding. He was about thirty-five years old. He fished as the law provided. He drank, at times getting drunk and would fight at the drop of a hat. He informed me that he never did anything for a living but fish; that he had $4,200 in the bank and had twelve $20 bills in his pocket, and showed me the bills. He took down another purse, well filled, from the rafters from behind cobwebs. How much money his wife had taken with her on her visit to Georgia he did not say. He had a comfortable little home, a launch and fishing net and about $1,000 worth of hogs. It is likely he fought, drank and spent his money until twenty-five years old and, since marrying (in ten years), by legal fishing had supported a wife and accumulated in cash and other property some six or seven thousand dollars.

Who, being a man who must earn his bread by the sweat of his brow, would not prefer to be a Florida commercial fisherman? No noxious gas of the mine to suffocate him; no smoke and noise of the factory to stifle and deafen him; no burning sun to blister him as he turns the furrow; no hard-hearted boss to find fault and bulldoze him. Pure air fills his lungs. Instead of deafening

noises and stifling smoke, he hears the songs of birds and smells the perfume of flowers. No man his superior, the equal of kings. Enjoying all these advantages, he yet by frugality and industry can earn more than a living and be able to lay by something for a stormy day. He is his own master. During the summer he goes forth in the night and cool breezes blow upon his brow. During the winter he goes forth by day and the warm sun cheers him. If fishing by night, ever the stars shining brightly above give him hope; if fishing by day, the wavelets as they break against his boat murmur encouragement.

To those of you who are scientific, no field is so pregnant with discussion as Florida waters. To those of you who represent states that furnish for their own consumption less than their demands, I suggest to you that you refer your dealers to Florida markets for their supplies. To all of you, and to all those you represent, who delight in the sport of fishing, we invite you to any of our waters.

American Fisheries Society

ORGANIZED 1870

CERTIFICATE OF INCORPORATION.

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish with power:

(*a*) To acquire, hold and convey real estate and other property, and to establish general and special funds.

(*b*) To hold meetings.

(*c*) To publish and distribute documents.

(*d*) To conduct lectures.

(*e*) To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

(*f*) To acquire and maintain a library.

(*g*) And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER (Seal)
THEODORE GILL (Seal)
WILLIAM E. MEENAN (Seal)
THEODORE S. PALMER (Seal)
BERTRAND H. ROBERTS (Seal)
HUGH M. SMITH (Seal)
RICHARD SYLVESTER (Seal)

Recorded April 16, 1911.

Presidents, Terms of Service and Places of Meeting.

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

1.	William Clift	1870–1872	New York, N. Y.
2.	William Clift	1872–1873	Albany, N. Y.
3.	William Clift	1873–1874	New York, N. Y.
4.	Robert B. Roosevelt	1874–1875	New York, N. Y.
5.	Robert B. Roosevelt	1875–1876	New York, N. Y.
6.	Robert B. Roosevelt	1876–1877*	New York, N. Y.
7.	Robert B. Roosevelt	1877–1878	New York, N. Y.
8.	Robert B. Roosevelt	1878–1879	New York, N. Y.
9.	Robert B. Roosevelt	1879–1880	New York, N. Y.
10.	Robert B. Roosevelt	1880–1881	New York, N. Y.
11.	Robert B. Roosevelt	1881–1882	New York, N. Y.
12.	George Shepard Page	1882–1883	New York, N. Y.
13.	James Benkard	1883–1884	New York, N. Y.
14.	Theodore Lyman	1884–1885	Washington, D. C.
15.	Marshall McDonald	1885–1886	Washington, D. C.
16.	W. M. Hudson	1886–1887	Chicago, Ill.
17.	William L. May	1887–1888	Washington, D. C.
18.	John H. Bissell	1888–1889	Detroit, Mich.
19.	Eugene G. Blackford	1889–1890	Philadelphia, Pa.
20.	Eugene G. Blackford	1890–1891	Put-in-Bay, Ohio.
21.	James A. Henshall	1891–1892	Washington, D. C.
22.	Herschel Whitaker	1892–1893	New York, N. Y.
23.	Henry C. Ford	1893–1894	Chicago, Ill.
24.	William L. May	1894–1895	Philadelphia, Pa.
25.	L. D. Huntington	1895–1896	New York, N. Y.
26.	Herschel Whitaker	1896–1897	New York, N. Y.
27.	William L. May	1897–1898	Detroit, Mich.
28.	George F. Peabody	1898–1899	Omaha, Neb.
29.	John W. Titcomb	1899–1900	Niagara Falls, N. Y.
30.	F. B. Dickerson	1900–1901	Woods Hole, Mass.
31.	E. E. Bryant	1901–1902	Milwaukee, Wis.
32.	George M. Bowers	1902–1903	Put-in-Bay, Ohio.
33.	Frank N. Clark	1903–1904	Woods Hole, Mass.
34.	Henry T. Root	1904–1905	Atlantic City, N. J.
35.	C. D. Joslyn	1905–1906	White Sulphur Spgs, W. Va.
36.	E. A. Birge	1906–1907	Grand Rapids, Mich.
37.	Hugh M. Smith	1907–1908	Erie, Pa.
38.	Tarleton H. Bean	1908–1909	Washington, D. C.
39.	Seymour Bower	1909–1910	Toledo, Ohio.
40.	William E. Meehan	1910–1911	New York, N. Y.
41.	S. F. Fullerton	1911–1912	St. Louis, Mo.
42.	Charles H. Townsend	1912–1913	Denver, Colo.
43.	Henry B. Ward	1913–1914	Boston, Mass.
44.	Daniel B. Fearing	1914–1915	Washington, D. C.
45.	Jacob Reighard	1915–1916	San Francisco, Cal.
46.	Geo. W. Field	1916–1917	New Orleans, La.
47.	Henry O'Malley	1917–1918	St. Paul, Minn.
48.	M. L. Alexander	1918–1919	New York, N. Y.
49.	Carlos Avery	1919–1920	Louisville, Ky.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

LIST OF MEMBERS, 1919-1920

Showing Year of Election to Membership

HONORARY MEMBERS

The President of the United States.....Woodrow Wilson

The Governors of the several States:

Alabama.....Thomas E. Kilby
Arizona.....Thomas E. Campbell
Arkansas.....Chas. H. Brough
California.....William B. Stephens
Colorado.....Oliver H. Shont
Connecticut.....Marcus H. Holcomb
Delaware.....John G. Townsend, Jr.
Florida.....Sidney J. Catts
Georgia.....Hugh M. Dorsey
Idaho.....D. W. Davis
Illinois.....Frank O. Lowden
Indiana.....Jas. P. Goodrich
Iowa.....Wm. L. Harding
Kansas.....Henry Allen
Kentucky.....Edwin P. Morrow
Louisiana.....Ruffin G. Pleasant
Maine.....Carl E. Milliken
Maryland.....Albert C. Ritchie
Massachusetts.....Calvin Coolidge
Michigan.....Albert E. Sleeper
Minnesota.....J. A. A. Burnquist
Mississippi.....Lee M. Russell
Missouri.....Frederick D. Gardner
Montana.....Samuel V. Stewart
Nebraska.....Samuel R. McKelvie
Nevada.....Emmet D. Boyle
New Hampshire.....John H. Bartlett
New Jersey.....Edward I. Edwards
New Mexico.....Octaviano A. Larrazolo
New York.....Alfred E. Smith
North Carolina.....Thomas W. Bickett
North Dakota.....Lynn J. Frazier
Ohio.....James M. Cox
Oklahoma.....J. B. A. Robertson
Oregon.....B. W. Olcott
Pennsylvania.....Wm. C. Sproul
Rhode Island.....R. Livingston Beeckman
South Carolina.....Robert A. Cooper
South Dakota.....Peter Norbeck
Tennessee.....A. H. Roberts
Texas.....W. P. Hobby
Utah.....Simon Bamberger
Vermont.....Horace F. Graham
Virginia.....Westmoreland Davis
Washington.....Louis F. Hart
West Virginia.....John J. Cornwell
Wisconsin.....E. L. Phillips
Wyoming.....Robert D. Carey

'08 Antipa, Prof. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.
'06 Besana, Giuseppe, Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy.
'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.
'93 Borodin, Nicolas, Petrograd, Russia.
'12 Calderwood, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.
'04 Denbigh, Lord, London, England.
'89 Fish Protective Association of Eastern Pennsylvania, 1020 Arch St., Philadelphia, Pa.
'04 Fryer, Sir Charles E., Royal Automobile Club, London, England.
'06 Grimm, Dr. Oscar, Petrograd, Russia.
'04 Kishinouye, Dr. K., Imperial University, Tokyo, Japan.
'08 Kitahara, Dr. Tasaku, Imperial Fisheries Bureau, Tokyo, Japan.
'88 Lake St. Clair Shooting and Fishing Club, Detroit, Mich.
'17 Mercier, Honore, Minister of Colonization, Mines and Fisheries, Quebec, Canada.
'09 Nagel, Hon. Chas., St. Louis, Mo.
'95 New York Association for the Protection of Fish and Game, New York City.
'08 Nordqvist, Dr. Oscar Fritjof, Superintendent of Fisheries, Lund, Sweden.
'06 Perrier, Prof. Edmond, Director Museum of Natural History, Paris, France.
'92 Vinciguerra, Prof. Dr. Decio, Director Royal Fish Cultural Station, Rome, Italy.

CORRESPONDING MEMBERS

'84 Apostolides, Prof. Nicoly Chr., Athens, Greece.
'87 Armistead, J. J., Dumfries, Scotland.
'04 Ayson, L. F., Commissioner of Fisheries, Wellington, New Zealand.
'09 Flegel, Chas., Canea, Crete.
'08 Higginson, Edurado, Consul for Peru, New York City.
'84 Landmark, A., Inspector of Norwegian Fresh-Water Fisheries, Christiania, Norway.
'84 Marston, R. B., Editor of the Fishing Gazette, London, England.
'08 Potteau, Charnley, Lommel, Belgium.
'84 Raveret-Wattel, C., Director of Aquicultural Station at Nid-de-Verdier, 20 Rue des Acacias, Paris.
'84 Sars, Prof. G. O., Christiania, Norway.
'84 Solsky, Baron N. de, Director of the Imperial Agricultural Museum, Petrograd, Russia.
'10 Stead, David G., Fisheries Department, Sydney, New South Wales, Australia.

PATRONS

'14 Alaska Packers Association, San Francisco, Cal.
'15 Allen, Henry F. (Agent, Crown Mills), 210 California St., San Francisco, Cal.
'15 American Biscuit Co., 815 Battery St., San Francisco, Cal.
'15 American Can Co., Mills Building, San Francisco, Cal.
'15 Armour & Co., Battery and Union Sts., San Francisco, Cal.
'15 Armsby, J. K., Company, San Francisco, Cal.
'15 Atlas Gas Engine Co., Inc., Foot of 22d Avenue, Oakland, Cal.
'15 Balfour, Guthrie & Co., 350 California St., San Francisco, Cal.

'15 Bank of California, N. A., California and Sansome Sts., San Francisco, Cal.
'15 Bloedel-Donovan Lumber Mills, Bellingham, Wash.
'15 Bond and Goodwin, 485 California St., San Francisco, Cal.
'15 Burpe and Letson, Ltd., South Bellingham, Wash.
'15 California Barrel Co., 22d and Illinois Sts., San Francisco, Cal.
'15 California Door Co., 43 Main St., San Francisco, Cal.
'15 California Stevedore and Ballast Co., Inc., 210 California St., San Francisco, Cal.
'15 California Wire Cloth Company, San Francisco, Cal.
'15 Caswell, Geo. W., Co., Inc., 503–4 Folsom St., San Francisco, Cal.
'15 Clinch, C. G., & Co., Inc., 144 Davis St., San Francisco, Cal.
'15 Coffin-Redington Co., 35–45 Second St., San Francisco, Cal.
'15 Columbia River Packers' Association, Astoria, Ore.
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'18 Moore, Dr. Emmeline, Conservation Commission, Albany, N. Y.
'04 Moore, Dr. H. F., U. S. Bureau of Fisheries, Washington, D. C.
'05 Morcher, George, London, Ohio.
'15 Morgulis, Dr. Sergius, Creighton Univ., Omaha, Nebr.
'18 Morley, E. C., Sodus Point, N. Y.
'04 Morris, Dr. Robert T., 616 Madison Ave., New York City.
'99 Morton, W. P., 105 Sterling Ave., Providence, R. I.
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'86 Nevin, James, Conservation Commission, Madison, Wis.
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'18 New York Public Library, 476 Fifth Ave., New York, N. Y.
'18 New York State Library, Albany, N. Y.
'10 Nichols, John Treadwell, American Museum of Natural History, New York City.
'16 Nilson, L. A., Orangeburg, S. C.

'13 Oakes, Wm. H., 24 Union Park St., Boston, Mass.
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'04 Palmer, Dr. Theodore S., United States Department of Agriculture, Washington, D. C.
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'07 Patching, Fred, Loring, Alaska.
'18 Pearse, Prof. A. S., University of Wisconsin, Madison, Wis.
'11 Pell, Geo. W., 520 Sixteenth St., Denver, Colo.
'05 Peoples, Hiram, New Providence, Pa.

'09 Pfleuger, J. E., Akron, Ohio.
'17 Pinkerton, J. A., Glenwood, Minn.
'13 Poole, Gardner, Fish Pier, Boston, Mass.
'11 Pohoqualine Fish Association, care of C. Wetherill, 17th and Lehigh Ave., Philadelphia, Pa.
'09 Pomeroy, Geo. E., Toledo, Ohio.
'04 Pope, T. E. B., Curator, Public Museum of the City of Milwaukee, Milwaukee, Wis.
'06 Porter, Richard, Board of State Fish Commissioners, Paris, Mo.
'19 Post Fish Co., Sandusky, Ohio.
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'10 *Radcliffe, Lewis, U. S. Bureau of Fisheries, Washington, D. C.
'18 Rankin, Edward P., care Miss O'Connor, San Lorenzo, Cal.
'93 Ravenel, W. de C., U. S. National Museum, Washington, D. C.
'16 Ray, J. E., Alexandria, La.
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'19 Rodd, J. A., Dept. Naval Service, Ottawa, Canada.
'10 Rowe, Henry C., Daytona Beach, Fla.
'16 Rowe, Wm. H., West Buxton, Me.
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'13 Ryan, Calvin D., U. S. Bureau of Fisheries, Ketchikan, Alaska.

'05 *Safford, W. H., U. S. Bureau of Fisheries, Gloucester, Mass.
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'17 Selvog, Hans R., Warroad, Minn.

'13 Shellford, Victor E., Dept. Zool., University of Illinois, Urbana, Ill.
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'05 Snyder, J. P., U. S. Bureau of Fisheries, Cape Vincent, N. Y.
'08 Speaks, John C., Columbus, Ohio.
'87 Spensley, Calvert, Mineral Point, Wis.
'17 Sportsmen's Review Publishing Co., 15 W. Sixth St., Cincinnati, Ohio.
'16 Spragle, L. H., Henryville, Pa.
'19 St. John, Larry, Chicago Tribune, Chicago, Ill.
'10 Stack, F. George, Summitville, Sullivan Co., N. Y.
'15 Starr, G. D., Lewis Bldg., Portland, Oregon.
'00 Starr, W. J., State Board of Fish Commissioners, Eau Claire, Wis.
'03 Steele, G. F., Sun Life Bldg., Montreal, Canada.
'03 Stevens, Arthur F., Ladentown, R. F. D. 44-A, Suffern, N. Y.
'12 Stivers, D. Gay, Butte Anglers' Association, Butte, Mont.
'04 Story, John A., U. S. Bureau of Fisheries, Green Lake, Me.
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'08 Thomson, G. H., Estes Park, Col.
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'14 Tillman, Robert L., Beacon Paper Co., St. Louis, Mo.
'13 *Timson, Wm., Vice-President, Alaska Packers Assn., San Francisco, Cal.
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'13 Trexler, Col. Harry C., Allentown, Pa.
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'18 Turner, Prof. C. L., Beloit College, Beloit, Wis.

'11 *Vallette, Luciano H., Chief of Section of Fish Culture, 827 Rivadavia, Buenos Aires, Argentina.
'09 Van Atta, Clyde H., U. S. Bureau of Fisheries, Yes Bay Hatchery, Ketchikan, Alaska.
'19 Van Cleave, Prof. H. J., University of Illinois, Urbana, Ill.
'14 *Vandergrift, S. H., 1728 New Hampshire Ave., Washington, D. C.
'19 Viosia, Percy, Jr., Natural History Bldg., New Orleans, La.
'19 Vincent, W. S., U. S. Bureau of Fisheries, Mammoth Spring, Ark.
'12 Vogt, James H., Nevada Fish Commission, Verdi, Nevada.
'09 Von Lengerke, J., 200 Fifth Ave., New York City.

'06 Waddell, John, Grand Rapids, Mich.
'19 Wagner, John, School House Lane, Germantown, Philadelphia, Pa.
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'96 Walker, Bryant, Detroit, Mich.
'11 Walker, Dr. H. T., 210 Main St., Denison, Texas.
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'19 Wallace, Col. John H., Jr., Montgomery, Ala.
'96 Walters, C. H., Cold Spring Harbor, N. Y.
'98 Ward, Prof. H. B., University of Illinois, Urbana, Ill.
'12 Ward, J. Quincy, Executive Agent, Kentucky Game and Fish Commission, Frankfort, Ky.
'17 Ward, Robertson S., 172 Harrison St., East Orange, N. J.
'13 Webb, W. Seward, 44th St. and Vanderbilt Ave., New York City.
'16 Weeks, Andrew Gray, 8 Congress St., Boston, Mass.
'17 Welsch, H. N., Box 4, Salt Lake City, Utah.
'15 Welsch, R., Bellingham, Wash.
'19 Werrick, Frank J., Bigrock Creek Trout Club, St. Croix Falls, Wis.
'13 Westerfeld, Carl, 702 Postal Bldg., San Francisco, Cal.
'13 Westermann, J. H., Harrietta, Mich.
'19 Wheeler, Chas. E., Stratford, Conn.
'15 Wheeler, Fred M., 546 Fulton St., Chicago, Ill.
'18 White, Jas., Conservation Commission, Ottawa, Canada.
'10 Whitman, Edward C., Canso, Nova Scotia, Canada.
'15 Whiteside, R. B., 204 Sellwood Bldg., Duluth, Minn.
'19 Wickliff, Edward L., 1309 Atchinson St., Columbus, Ohio.
'17 Williams, J. A., Shell-Fish Commissioner, Tallahassee, Fla.
'01 Wilson, C. H., Glen Falls, N. Y.
'10 Winchester, Grant E., Forest, Fish and Game Commission, Bemus Point, N. Y.
'00 Winn, Dennis, U. S. Bureau of Fisheries, 1217 L. C. Smith Bldg., Seattle, Wash.
'99 Wires, S. P., U. S. Bureau of Fisheries, Duluth, Minn.
'13 *Wisner, J. Nelson, Director, Institute de Pesca del Uurguay, Punta del Esto, Uruguay.
'05 *Wolters, Chas. A., Oxford and Marvine Streets, Philadelphia, Pa.
'97 Wood, C. C., Plymouth, Mass.
'13 Woods, John P., President, Missouri State Fish Commission, First and Wright Sts., St. Louis, Mo.
'14 Work, Gerald, Perkins Hill, Akron, Ohio.
'84 Worth, S. G., 518 Colonial Ave., Norfolk, Va.
'19 Wright, Prof. Albert Hazen, Cornell University, Ithaca, N. Y.

'09 Yerington, Edward B., Board of Fish Commissioners, Carson City, Nevada.
'16 Younger, R. J., Houma, La.

'99 Zalsman, P. G., Grayling, Mich.

MEMBERS ADMITTED AT MEETING, SEPTEMBER, 1920.

BARBOUR, F. K., 96 Franklin St., New York, N. Y.
BAXTER, A. C., Chief, Ohio Fish and Game Division, Columbus, Ohio.
CRIE, H. D., Director, Sea and Shore Fisheries Commission, Rockland, Me.
DREISBACH, LEON, Erie, Pa.
DOLAN, GEORGE A., Fish Commissioner, Westerly, R. I.
FINLAYSON, ALEX C., Dominion Inspector of Hatcheries, Ottawa, Canada.
GREENE, JOHN V., Assistant, U. S. Bureau of Fisheries, Washington, D. C.
GOULD, EDWIN W., State Sea Food Protective Commission, Portland, Me.
KIPLINGER, WALTER C., 2234 Park Ave., Indianapolis, Ind.
MACKAY, D. A., Collegiate Institute, Ottawa, Canada.
MILES, LEE, Probate Judge, Little Rock, Ark.
RICH, WALTER H., Agent, Bureau of Fisheries, Falmouth, Me.
STUBER, JAMES W., Bureau of Fish and Game, Columbus, Ohio.
TRAVERS, JOHN T., Fish and Game Dept., Columbus, Ohio.
VICKERS, HARRISON W., Chairman, Conservation Commission, 512 Munsey Building, Baltimore, Md.
WALKER, S. J., District Inspector of Hatcheries, Ottawa, Canada.
WELLS, WM. F., Conservation Commissioner, Albany, N. Y.
WHITEWAY, SOLOMON P., St. Johns, Newfoundland.
WILBUR, HARRY C., Commissioner, Sea and Shore Fisheries, Portland, Me.

RECAPITULATION.

Honorary	67
Corresponding	12
Patrons	53
Active	563
Total	695

CONSTITUTION

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERSHIP

Active Members.—Any person may, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Libraries may become members on the payment of the two dollar annual fee.

Any sporting or fishing club, society, firm or corporation may upon the payment of an annual fee of five dollars, become a member of this Society and entitled to all its publications.

Any State board or commission, upon the payment of an annual fee of two dollars, may become a member of this Society and entilled to all its publications.

Life Members.—Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, vecome a life member of this Society, and shall thereafter be exempt from all annual dues.

Patrons.—Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50.00, may become a Patron of this Society with all the privileges of a

life member, and than shall be listed as such in all published lists of the Society. The money thus received shall become part of the permanent funds of the Society and the interest alone be used as the Society shall designate.

Honorary and Corresponding Members.—Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several States shall be honorary members of the Society.

Election of Members Between Annual Meetings.—The President, Recording Secretary and Treasurer of the Society are hereby authorized, during the time intervening between annual meetings, to act on all individual applications for membership in the Society, a majority vote of the Committee to elect or reject such applications as may be duly made.

ARTICLE III

SECTIONS

On presentation of a formal written petition signed by one hundred or more members, the Executive Committee of the American Fisheries Society may approve the formation in any region of a Section of the American Fisheries Society to be known as the ——— Section.

Such a Section may organize by electing its own officers, and by adopting such rules as are not in conflict with the Constitution and By-Laws of the American Fisheries Society.

It may hold meetings and otherwise advance the general interests of the Society, except that the time and place of its annual meeting must receive the approval of the Executive Committee of the American Fisheries Society, and that without specific vote of the American Fisheries Society, the Section shall not commit itself to any expression of public policy on fishing matters.

It may further incur indebtedness to an amount necessary for the conduct of its work not to exceed one-half of the sum received in annual dues from members of said section.

Such bills duly approved by the Chairman and Recorder of the Section shall be paid on presentation to the Treasurer of the American Fisheries Society.

ARTICLE IV

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an editor, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

Vice-presidents of sections may be called upon by the President to present reports of the work of their sections, or they may voluntarily present such reports when material of particular value can be offered by a given division.

ARTICLE V

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE VI

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
   a. President.
   b. Secretary.
   c. Treasurer.
   d. Vice-Presidents of Divisions.
   e. Standing Committees.
5. Committees appointed by the president.
   a. Committee of five on nomination of officers for ensuing year.
   b. Committee of three on time and place of next meeting.
   c. Auditing committee of three.
   d. Committee of three on programme.
   e. Committee of three on publication.
   f. Committee of three on publicity.
6. Reading of papers and discussion of same.

   (Note—In the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VII

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

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